PUBLIC
S.F.
LIBRARY

OVERSIZE 6

BROOKS HALL

SAN FRANCISCO PUBLIC LIBRARY

VITA SINE LITERIS MORS EST

Book No. 625.7 C125 1

Accession 339790

NOT TO BE TAKEN FROM THE LIBRARY

FORM 3427—5M—2-39

SAN FRANCISCO PUBLIC LIBRARY
3 1223 05429 0409

Digitized by the Internet Archive
in 2012 with funding from
California State Library Califa/LSTA Grant

http://archive.org/details/californiahighwa191216cal

TG25.7
C125
339790

CALIFORNIA HIGHWAY BULLETIN

Volume I SACRAMENTO, CAL., OCTOBER 15, 1912. Number 1

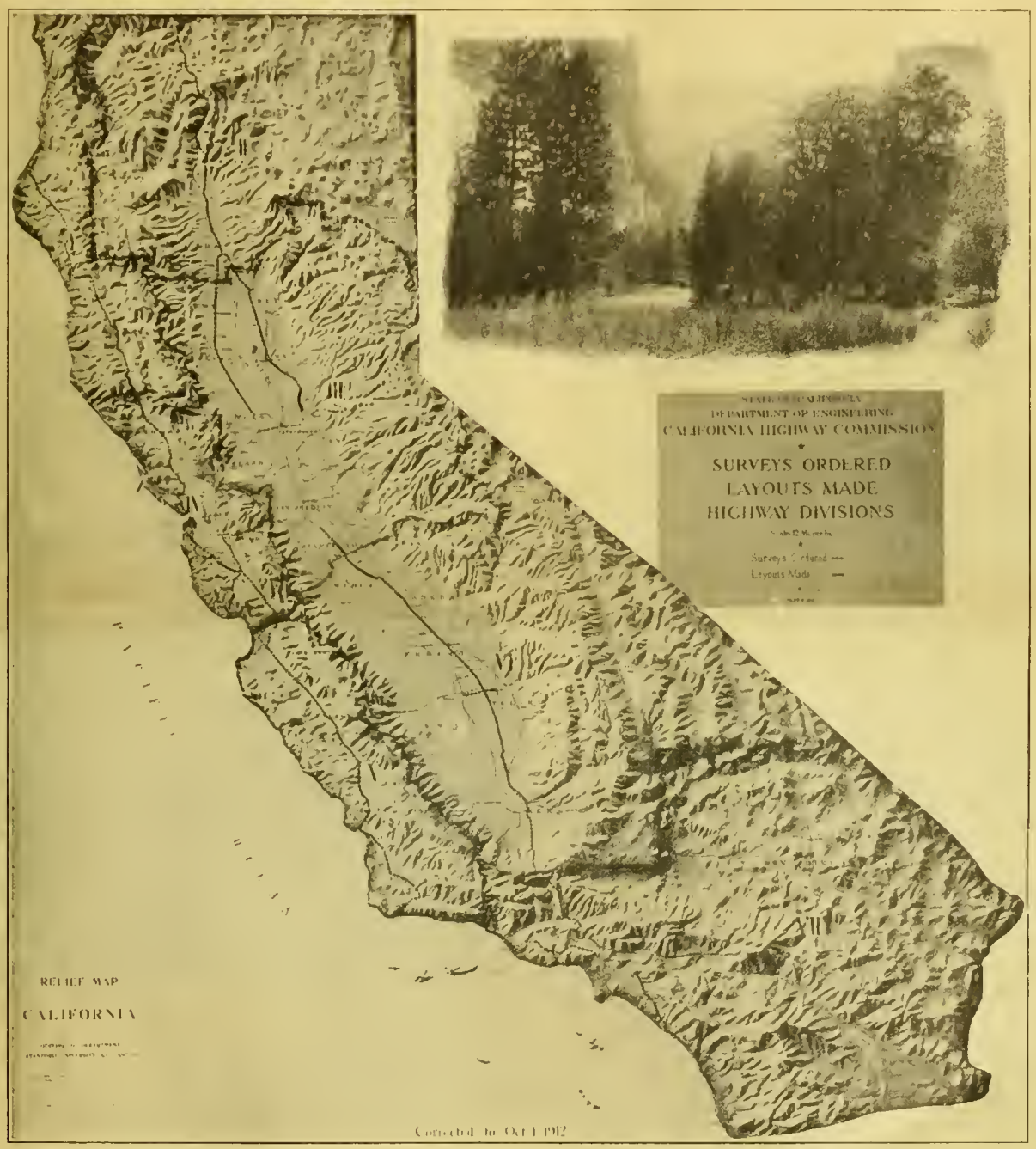


TABLE OF CONTENTS AND ILLUSTRATIONS

The Good Road Builder - - - - - - 2
A Foreword - - - - - - - - - - 2
Freight and Material Contracts - - - - 2
Questionable Paving Patents - - - - - 2
County Highway Work - - - - - - - 2
Save the Native Trees Along the Highway - - 3
Bridges, Trestles and Culverts - - - - - 3
Routing the California State Highway - - - 4
Attorney General Webb's Opinion - - - - 5
The Engineering Department - - - - - 7
Counties Provide Rights of Way and Bridges - 8
Progress of the State Highway in Yuba - - - 8
Employees Appointed Solely on Merit - - - 9
Where the Money Goes - - - - - - 10
Geological and Laboratory Department - - 10
San Luis Starts Condemnation Proceedings - 10
One Thousand Miles of Highway Surveyed - 11
A Statement From the Highway Engineer - - 12
Municipal League Committee's Report - - - 13
Anti-Road Sign Movement - - - - - - 14
Warning Signs for Torn-up Roads - - - - 15
Building the Highway Through Cities - - - 15
Organization - - - - - - - - - - 16
The Power of the Press - - - - - - - 16
The Maintenance Problem - - - - - - - 16
Gov. Johnson, Chairman of the Advisory Board 16

ILLUSTRATIONS.

Relief Map Showing State Highway Routes - 1
Yosemite Valley (Vignette) - - - - - - 1
In the Tall Timber of Humboldt County - - 3
Rincon Causeway, Ventura County - - - - 4
Three Miles of State Highway Near Marysville - 6
Building the State Highway Near Burlingame - 7
Pismo Beach, San Luis Obispo - - - - 8
San Luis Rey Bridge, San Diego County - - 9
Building State Highway Near Marysville - - 10
A Mountain Grade in Mendocino - - - - 13
"Old Shasta" is on the State Highway - - 15
Organization Chart—C. H. C. - - - - - 16

ORNIA HIGHWAY BULLETIN

PUBLISHED BI-MONTHLY BY THE

CALIFORNIA HIGHWAY COMMISSION

OF THE

Department of Engineering

State of California

BURTON A. TOWNE, CHAS. D. BLANEY, N. D. DARLINGTON
Commissioners

AUSTIN B. FLETCHER, Highway Engineer

W. R. ELLIS, Secretary

Forum Building, Sacramento, California

DIVISION ENGINEERS—OFFICE ADDRESSES:

Division I. F. G. SOMNER, ... Willits, Mercantile Building
Division II. T. A. BEDFORD, ... Redding, C. R. Briggs Building
Division III. W. S. CARUTHERS, ... Sacramento, Forum Building
Division IV. A. E. LODER, ... San Francisco, Rialto Building
Division V. W. C. HOWE, ... San Luis Obispo, Union National Bank Building
Division VI. J. B. WOODSON, ... Fresno, Forsyth Building
Division VII. W. L. CLARK, ... Los Angeles, Union Oil Building

THE GOOD ROAD BUILDER FIRST SURVEYS THE ROUTE;
HE STARTS FROM SOMEWHERE TO GO SOMEWHERE;
HE SHOWS HOW IT IS DONE;
HE MAKES TRAVELING EASIER FOR OTHERS.

A FOREWORD

Widespread interest in the state highway undertaking calls for the publication from time to time of a report from the California Highway Commission. Therefore, this Bulletin.

It is a state document. Its purpose is to present authoritative reviews of the work accomplished and forecasts of the plans proposed by the Commission under the State Highways Act of 1909.

The Commission plans to issue the Bulletin every two months. Copies will be mailed regularly upon application to those interested.

Freight and Material Contracts

In its endeavor to make the $18,000,000 build as many miles of highway as practicable and do good work, the California Highway Commission has undertaken:

First—To obtain from the different railroad companies a schedule of freight rates on road materials, substantially reducing the schedule of published tariffs.

Second—To secure from the cement dealers an agreement to make a wholesale price to the state for the required cement below the going market rate for that commodity.

Third—To contract to reduce rates with owners of rock quarries and gravel deposits for the delivery of large quantities of broken stone and gravel, these materials to be shipped as required during the life of the work.

Already the Commission has arrived at an understanding with the transportation companies under which there will accrue to the state a saving of hundreds of thousands of dollars in the hauling of the road materials by rail.

A substantial reduction in the price of cement has been offered, but the figures are not as close as the Commission expects yet to obtain from the cement producers.

Reductions on nearly half a million tons of broken stone and gravel have been agreed upon in contracts now being executed with quarry owners, the price obtained by the Commission being at least 25 per cent per ton lower than the going rates.

In purchasing the materials directly, the Commission believes that many contractors, who by reason of limited capital or credit are not ordinarily able to finance large construction works, will be enabled to undertake successfully the state highway contracts.

The Commission does not consider that in the interest of the people the contract work should be controlled by a limited coterie of opulent contracting firms. There is plenty of room on the state highway for large and small, and without crowding.

The quality of materials may be better controlled by the State furnishing them, and the burden of the inspection of the work is lightened, since the engineers will need attend to the working processes only. With materials furnished to him, the contractor is not tempted to "scamp" on either quality or measurement.

To insure that proper materials are supplied, a laboratory suitably equipped with apparatus and in charge of a testing engineer has been established. Elsewhere in this Bulletin, the laboratory and its activities are described.

Questionable Paving Patents

The position of the California Highway Commission is that if there are any royalties to be paid for the use of any pavement or pavement processes in the construction of the state highway, the State will assume the responsibility, if the courts shall determine that the use of such pavements or processes is subject to claims for royalties under valid patents, and if the State by such use has committed a tort for which it is liable.

The policy of the United States Patent Office, in issuing letters of patents for road types and processes so freely and with so little apparent discrimination, has resulted in much confusion. These patents are so numerous and conflicting in their claims that neither the contractors nor the engineers are ever sure of doing their work unharassed by claims of alleged patentees.

The immediate result of this turmoil and uncertainty is that the people in many instances pay more than is right for their roads and streets. In self-defense, the contractor must bid sufficiently high so as to protect himself against embarrassment if he is called upon to defend himself against claims for royalties, even if he believes that the work for which proposals are asked does not infringe upon any valid patent.

Often a suspicion exists that both the contractors and the persons claiming patents are increasing their incomes unduly at the cost of the people.

The Commission is of the opinion that if royalties must be paid, it will show better in the final analysis if such royalties are paid directly from the public treasury.

County Highway Work

That the state highway undertaking has aroused public interest in good roads throughout the State of California, is evidenced by the activities of various counties in preparing to permanently improve their respective county highway systems and connect them with the state's trunk roads.

Credit is particularly due to Sacramento, Los Angeles, San Diego and San Joaquin counties for having "pioneered" in independent efforts to substantially improve their public roads. In September, 1907, Sacramento voted bonds in the sum of $825,000 for good road purposes; $600,000 to cover the construction of one hundred and four miles of highways and $225,000 for building bridges. About the same time, Los Angeles voted $3,500,000 for like purposes. On March 16, 1908, San Joaquin followed suit by bonding itself for $1,890,000 for good roads, and on August 3, 1909, San Diego pledged her credit in the sum of $1,250,000 to permanently improve her highway system.

Ventura County has already expended the most of its $250,000 of bonds for bridges, and has recently constructed by direct taxation a bridge over Ventura River at Ventura at a cost of $50,000.

San Benito County this year has bonded itself for $300,000 for county roads.

The latter part of 1911, Glenn County voted $290,000 for concrete bridges and $160,000 for highway improvements.

Among the counties that are now energetically agitating for the public improvement of their highways and are preparing to move aggressively in the matter are Orange, Santa Barbara, Yuba, Sonoma, Solano, Siskiyou, San Mateo, Amador, Stanislaus, Riverside, Butte, Tulare, and Humboldt.

Among the counties which report doing considerable road improvement work by direct taxation and which can show excellent results are Trinity, Tehama, Sutter, Santa Clara, Napa, Imperial, Contra Costa, and Mono.

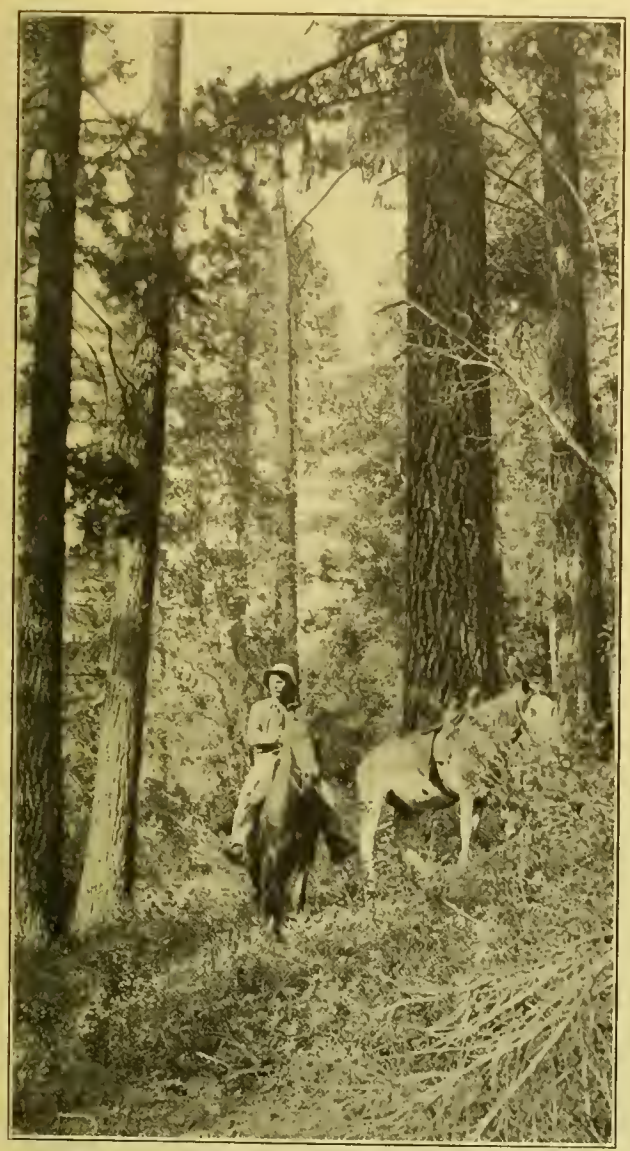
Del Norte County reports that the Supervisors are setting aside yearly 35 per cent of the general road fund for permanent road work. Last year they purchased a steam road roller, rock crushing plant and dump wagons at a cost of about $6,500, to assist in the work of road building.

From present indications, it may safely be prophesied that contemporaneously with the expenditure of the $18,000,000 voted by the State for highways, the various counties will in the aggregate spend $18,000,000 more in improving their tributary systems.

3 1223 05429 0409

SAVE THE NATIVE TREES ALONG THE HIGHWAY

Let the Standing Timber on all Rights of Way Go to the State Forever



In the Tall Timber of Humboldt County. Reconnoitering for the State Highway.

At the September session of the California Highway Commission, the following resolution was adopted:

> *Voted*, That it be the policy of the Commission that standing timber on rights of way of state highways in the forest districts of the State be preserved, and that rights of way be acquired with the standing timber thereon, and that landowners be encouraged to leave timber uncut for a considerable distance on both sides of state highways in order to enhance the scenic beauty and attractiveness through wooded portions of California.

It is pertinent in this connection to make public the following letter addressed by the Commission last April to the Board of Supervisors of Del Norte County:

April 27, 1912.

MR. E. E. COMMERFORD, *Chairman*,
Board of Supervisors Del Norte County, Crescent City, California.

MY DEAR SIR: Referring to your letter of April 10th, addressed to the California Highway Commission, which I acknowledged on April 26th, I am directed by the Commissioners to address you again, particularly with reference to the suggestion which you offered that, "if the State in accepting rights of way for the state highway would leave the ownership of the standing timber in the right of way in the present owners, the matter can be easily adjusted by the county and the owners of the land," etc.

These Commissioners are endeavoring to take the broad and farseeing view in routing the great highway, and to keep uppermost in mind the welfare of the State in all of its large and enduring aspects.

They have traveled thousands of miles throughout the length and breadth of the State and have been greatly gratified and encouraged to learn that intelligent public sentiment everywhere is cordially in favor of constructing this State highway in a manner that will not only best serve the State industrially and commercially but which will contribute most to the development of the State in opening up now inaccessible sections of the commonwealth and revealing to the world its grand natural beauties and resources.

In furtherance of this public spirited purpose, the people of a number of sections, notably in Humboldt and Santa Barbara, have given this Commission their enthusiastic assurance that wherever the State highway may be routed in these counties through native forests, they will endeavor not only to guarantee that the standing timber upon the rights of way acquired shall go to the State but that the timber on each side of said rights of way to a distance of one hundred feet shall also be dedicated to the public and preserved for the perpetual beautification of the state highway.

It is the purpose of this Commission in routing the state highway through forest lands to allow it to follow where necessary a winding course, thus avoiding as far as possible the destruction of native trees.

The people of Del Norte County surely appreciate that the state highway is worth every effort they can put forth not only to bring it to them but to make it what it ought to be, famous the world over for its scenic beauty.

Your people, naturally enough, have grown so familiar with your magnificent forests and mountain grandeur that you fail to appreciate this value. It is hoped, however, that your honorable Board of Supervisors will readily understand the spirit and intent of the Commission in urging you to fall in line with other sections of the State in the matter of seeing to it that not only the standing timber is left on all rights of way that your county may guarantee for the purposes of the highway but that the timber on both sides of the right of way, to a liberal distance, shall also be saved for all time for the enjoyment of all the people and the honor of Del Norte.

Hoping to hear from you further in regard to this important matter.

Very respectfully,

THE CALIFORNIA HIGHWAY COMMISSION,
W. R. ELLIS, Secretary.

The Commission believes that the various boards of supervisors, civic societies and the press throughout the State will cordially coöperate with it in encouraging this stand for the preservation of native trees of California along the state highway.

Bridges, Trestles and Culverts

At its last regular session, the Commission adopted minimum requirements for all new bridges, trestles and culverts, which do not carry street railways, built for the state highways, as follows:

(*a*) All such structures are to be designed by competent engineers and the plans, specifications and workmanship be subject to the inspection and approval of the Highway Engineer of the Department of Engineering.

(*b*) The width of such structures, exclusive of sidewalks, if any, shall be not less than 21 feet in the clear.

(*c*) Concrete bridges shall be designed to sustain, in addition to the dead load, a uniform live load of 150 pounds per square foot of roadway and the floor system to carry a 20-ton traction engine.

(*d*) Steel bridges of span less than 150 feet shall be designed to sustain, in addition to the dead load, a uniform live load of 100 pounds per square foot of roadway and the floor system to carry a 15-ton road roller; for spans in excess of 150 feet a uniform live load of 85 pounds per square foot of roadway, the floor system to carry a 15-ton road roller as in the case of spans of less than 150 feet.

(*e*) Trestles shall be designed to sustain, in addition to the dead load, a uniform live load of 150 pounds per square foot of roadway, and the floor system to carry a 15-ton road roller.

Further, that the Commission hereby declares itself in favor of concrete structures whenever such structures are consistently possible because of their substantial permanency.

THE CAREFULLY prepared paper by Highway Engineer A. B. Fletcher, which was read at the State Convention of Supervisors in Bakersfield last May, is left over to appear in the next Bulletin. It is a valuable contribution to good roads literature.

ROUTING THE CALIFORNIA STATE HIGHWAY

The Attorney General Confirms the Commission's Position

The great problem that confronted the California Highway Commission at the beginning was the interpretation of the meaning of the State Highways Act of 1909, as to the routing of the highway. It was found even with the aid of good lawyers that it was not an easy matter to construe the meaning of that act. Aside from the legal difficulties, there were two divergent and irreconcilable policies that were urged upon the Commission in locating the highway.

The situation compelled the Commission to take either one or the other horn of this dilemma. Either they must route the main highway by "the most direct and practicable route" in the language of the highways act, ignoring county lines and local interests to the end that the State as a whole should be best served, or in response to appeals from various counties, they must proceed to lay out this great highway in a series of county links, each link to be rather a part of and to serve the functions of a county system and to satisfy local travel.

There was in the beginning a popular notion, held even by county officials, that the eighteen million dollar highway fund was an immense grab bag, into which each county had an independent right to dip its hands for the money with which to construct public roads within its own jurisdiction, in accordance with its own ideas of what was expedient and best for itself.

It is an old axiom that the test of any law or rule is its universal application.

While making their preliminary tours over the State, during which they covered over six thousand miles up and down our great valleys and through the mountain districts, the Highway Commissioners had an opportunity to meet the people of the various sections of the State and to personally discuss with representative bodies the question of highway routes. The Commissioners at every opportunity thus offered, laid the matter before the people. The popular response was all but unanimous in declaring that it was the business of the California Highway Commission to lay out the great trunk lines of the state highway by the shortest and most feasible routes.

It was seen at once by the people themselves that if each county were permitted to dictate how the state highway should run through their particular section, it would be "as crooked as a ram's horn." It would be lengthened by hundreds of miles and its cost thereby proportionately increased. At the same time its value as a great thoroughfare, contributing to ready and convenient intercommunication between the widely separated portions of the State, would be greatly impaired.

If, for instance, in Butte County, the main highway were diverted to the county seat, Oroville, and then zigzagged back to make connections, and this were permitted to be the plan pursued in routing the state highway in other counties, Butte County people, in traveling through Tehama and Shasta to Siskiyou or through Yuba and Placer to Sacramento, would find themselves covering perhaps double the mileage that would be necessary if the highway were routed by the "most direct and practicable route."

Therefore, the people of Butte County, including the ambitious citizens of their thriving county seat, Oroville, united in declaring that Oroville waived all claim to be upon the main highway, and that Butte County would accept and be satisfied with any route of the main highway selected by the Commission through their county which would best serve the purpose of the State at large.

County after county, speaking through their Boards of Supervisors, likewise assured this Commission that as soon as it had in its discretion fixed the location of the main highway through their several counties, they would proceed at once to lay out and construct permanent county systems of roads to connect with and complete the Commission's highway scheme.

Just as naturally as a great river, like the Mississippi, flows down the trough of the valley, draining into the sea and inviting its tributaries to feed their volume into it, or as a great transcontinental railroad by the economic laws of traffic and engineering is necessarily constructed by the most direct and practicable routes, depending upon its tributary lines from both sides to complete its system, so naturally and inevitably it would seem that, in laying out a great state highway, directness should be recognized as the first and foremost requirement, in order that it may be serviceable as the main artery of a great highway system.

So interpreting the spirit and intent of the highways act, and so viewing in its large State-wide aspects the state highway problem, and upon the recommendation of the Highway Engineer, the California Highway Commission proceeded to fix the routes and commence active construction work.

Rincon Road Causeway, Ventura County. Built by Popular Subscription at Cost of over $32,000. To be Finished by California Highway Commission.

When Tulare and Kings counties were reached, however, a difficult situation presented itself. North of these counties, Fresno County extends from the Coast Range to the Sierra Nevada Mountains; south of them Kern likewise lies across the trough of the San Joaquin Valley. No difficulty had been encountered in finding the short cut, either across Fresno or Kern County, but on account of the fact that Kings lies duly west of Tulare and that the dividing line between them is somewhere near the trough of the valley, and from the further fact that Hanford, the county seat of Kings County, lies about twenty miles almost duly west of Visalia, the county seat of Tulare, it is apparent that it was physically impossible to route the main highway by a practical direct line out of Fresno County through Hanford, then easterly through Visalia and then southerly to Bakersfield.

After the most deliberate and painstaking investigation of the situation, the Commission and the Highway Engineer agreed that the only practical solution to the situation was to continue the main highway in direct line from Fresno to Kern, passing between Hanford on the west and Visalia on the east, and constructing laterals to connect each with the main highway; and it was so ordered.

The people of these two communities were disappointed at the prospects of being left off of the main highway. Through State Senator Larkin of Tulare County, the matter was brought to the attention of his Excellency, Hon. Hiram W. Johnson, Governor, who referred the questions raised by the contentions of the Hanford-Visalia people to Attorney General U. S. Webb.

The issues thus raised are of vital importance as affecting the present work in hand and the future policy that shall govern the Advisory Board of the Engineering Department, of which the California Highway Commission is an executive committee. It is pertinent, therefore, to publish in full the letter of the Governor to the Attorney General with the opinion as delivered by the latter officer to the Governor.

Viewing the questions raised by the Governor's letter from a purely legal standpoint, the Attorney General gives a clear cut and unequivocal definition of the meaning of the law, and which in all respects sustains the position taken by the California Highway Commission in the matter of selecting routes for the state highway.

The Attorney General's Opinion

STATE OF CALIFORNIA.

OFFICE OF ATTORNEY GENERAL.

SAN FRANCISCO, August 22, 1912.

HON. HIRAM W. JOHNSON,
Governor of California, Sacramento.

DEAR SIR: I am in receipt of your communication of July 2, 1912, reading as follows:

> By what is termed the "State Highway Act," that is, the act wherein the $18,000,000 bonds were voted by the people, it is provided as follows:
> "The route or routes of said state highways shall be selected by the Department of Engineering, and said route shall be so selected and said highways so laid out and constructed or acquired as to constitute a continuous and connected state highway system, running north and south through the State, traversing the Sacramento and the San Joaquin valleys and along the Pacific coast by the most direct and practicable routes, connecting the county seats of the several counties through which it passes, and joining the centers of population together with such branch roads as may be necessary to connect therewith the several county seats lying east and west of such state highways."
> Recently some difference has arisen as to the construction of the language used. This difference has occurred in reference to the route proposed to be laid out from Fresno to Bakersfield. The people of Hanford and Visalia insist that legally these two county seats must be upon the route or routes of the state highways. Some have desired a direct highway to be run from Fresno to Bakersfield which would traverse practically the same route as the railroad tracks now traverse and which would not pass through either Hanford or Visalia, and the people of the latter two places argue that such a route, even though Hanford and Visalia might be connected by laterals with it, would not comply with the law and the provisions quoted, they insisting that it is mandatory that these county seats be connected as part of the route or routes of the state highways. Would you kindly give me your construction of the matter?
> Another matter that has caused some difficulty is the construction of the words "centers of population." It is insisted that on the one hand that this means the larger centers of population such as San Francisco, Los Angeles, Sacramento, Stockton and Fresno, and on the other hand that it refers to centers of population in the vicinity of the route even though such centers in comparison with the cities mentioned may be of small consequence in numbers. Would you please give me your construction of the meaning of the phrase?
> Would you also advise me whether in your opinion, the law contemplates that the county seats of Del Norte and Siskiyou be connected with the state line joining Oregon on the north and the county seats of Imperial and San Diego be connected with the state line joining Mexico on the south?
> You will observe that the phraseology is used "by the most direct and practicable routes," and immediately afterward the clause "connecting the county seats of the several counties through which it passes," and then following are these words "and joining the centers of population together with such branch roads as may be necessary," etc. Would you advise me whether this should be construed to mean that directness of route must be at all hazards observed or whether the joinings of "centers of population" is a desideratum?

In reply, permit me to say that the language of the "State Highway Act," approved March 22, 1909 (Stats. 1909, p. 647), so far as it relates to your questions, is ambiguous. Section 1 of that act provides, in part, as follows:

> A system of state highways in and for the State of California shall be constructed and acquired as and in the manner provided by law by the Department of Engineering of said State at a cost not to exceed eighteen million dollars.

Section 4 of that act, covering the matter before us, provides, in part, as follows:

> The moneys placed in the state highway fund, pursuant to the provisions of this section, shall be used exclusively for the acquisition of rights of way for and the acquisition and construction of said system of state highways. The route or routes of said state highways shall be selected by the Department of Engineering and said route shall be so selected and said highways so laid out and constructed or acquired as to constitute a continuous and connected state highway system running north and south through the state, traversing the Sacramento and San Joaquin valleys and along the Pacific coast by the most direct and practicable routes, connecting the county seats of the several counties through which it passes and joining the centers of population, together with such branch roads as may be necessary to connect therewith the several county seats lying east and west of such state highways.

THE STATUTE DOES NOT FIX THE ROUTE.

Of course, it is to be understood that it is not within my province to designate particularly any route or routes to be followed or the county seats or centers of population which shall have a situs upon any highway constructed. The geographical route of the state highway is not specifically confined by the statute to particular localities or places. The statute by its terms seems to contemplate only the indication of a general direction—from north to south—of the project. It would be an actual reduction to an absurdity to say that the statute, because of its terms, located and fixed a highway along a particular course, especially when one considers the topography of our State.

LEFT TO THE DEPARTMENT OF ENGINEERING.

These matters are, by the act, to be determined by the Department of Engineering. Any legal construction of the act, in such matters, can only be for the purpose of determining from a legal standpoint what the Legislature contemplated by the act which they have passed in so far as it bears upon the questions which you have asked me.

TWO MAIN HIGHWAYS CONTEMPLATED.

After considerable study, I am of the opinion that that statute contemplates a state highway system, comprising two main highways, each running in a general north and south direction throughout the State, and connected by branch roads with such county seats of the several counties as are not upon the main lines.

It will be noted that the Department of Engineering is to select the "*route or routes of said state highways,*" and, again, "state highways" are to be so laid out as to constitute a continuous and connected "state highway system."

BY THE MOST DIRECT AND PRACTICABLE ROUTE.

In indicating the general direction in which the system shall run, it is stated as "running north and south through the State, traversing the Sacramento and San Joaquin valleys and along the Pacific coast by the most direct and practicable route." Now, it would, of course, be impossible for one highway to run north and south through the State, traversing both those valleys and also run along the Pacific coast The most that could be done under that construction would be to run the highway from the most southerly point touched in the San Joaquin Valley westerly to the Pacific coast, and then south. But clearly that is not the route that was contemplated.

ALONG THE PACIFIC COAST.

Seemingly, by the expression "and along the Pacific coast," it was contemplated that there would be two routes, one running in a general direction north and south through the State, traversing the two main valleys mentioned, and the other in the same general direction north and south through the State, but traversing that region lying along the Pacific coast. Each of these two routes was to constitute a main highway, and was to be laid out by the most direct and practicable route.

CONNECTING THE COUNTY SEATS.

In the expression "Connecting the county seats of the several counties through which it passes," we have an intimation that it was not contemplated that the respective main highways were to connect upon the main line the county seats of all the counties. Had that been the intention, the act would have probably read: "connecting the county seats of all the counties," but that would have been impossible if the road was to run north and south by the most direct and practicable route. And that it was contemplated that there would be some county seats which would not be upon the main highways is shown by the last paragraph in the section of the statute quoted, which reads: "together with such branch roads as may be necessary to connect therewith the several county seats lying east and west of such state highway."

WHERE THE STATUTE IS MANDATORY.

I consider that the main purpose of the statute was to create a state highway system, running north and south through the State, as a means of communication for the entire State, in order that the people of the north might be in touch with the people of the south and the denizens of all the country between be brought in contact. And, for this reason, I consider that portion of the statute which provides for the construction of such highways in such manner as to "constitute a continuous

and connected state highway system running north and south through the State, traversing the Sacramento and San Joaquin valleys and along the Pacific coast by the most direct and practicable routes," as the portion of the statute which we are to treat as mandatory, and for the purpose of effecting the object displayed we must treat the balance of the statute as subordinate thereto.

JOINING CENTERS OF POPULATION.

In other words, our main idea of the highway in considering the routes should be that it is to run north and south by the most direct and practicable routes. And, with this idea in view, the connecting of the county seats of the several roads through which the highway passes and the joining of centers of population are but the incidents to the main idea of north and south direction by the most direct and practicable route.

SPECIFIC ANSWERS TO THE GOVERNOR'S QUESTIONS.

With this conception of the general intendments of the statute, I shall endeavor to answer the questions propounded by you in your communication.

1. With reference to your first question, permit me to say that it is evident that the main highway which shall traverse both the large interior valleys cannot pass through both Hanford and Visalia and at the same time comply with the mandate that it shall *run north and south by the most direct and practicable route.* Although it is evident that the Department of Engineering, in compliance with the main purpose of the act, may, in the exercise of its discretion, run that main highway through one of those two county seats, yet there is nothing in the act which makes it obligatory that either of those two places should be upon the line of that main highway. In the exercise of its discretion, in laying out such highway and keeping the required north and south trend by the most direct and practicable route, the Department of Engineering may find it best to run that highway from some point north of those two places through one of them or deflect it from both.

COUNTY SEATS NOT NECESSARILY ON THE MAIN HIGHWAY.

It is true that the act reads "connecting the county seats of the several counties through which it passes and joining the centers of population," and, from this, it might be argued that it was thereby intended that through whatever county the road ran, the county seat of that county must be within its path. This, however, would not be always practicable, for the main highway in the pursuit of a direct route might but touch or traverse one corner of a county at a point which would be some distance east or west of the county seat of that county; and it would then be in disregard of the mandate of the statute if the highway was then deflected to any considerable extent from its north and south trend merely for the purpose of connecting with it the county seat of that county.

CONNECTING COUNTY SEATS BY LATERALS.

Presumably, it was contemplated that in locating the highway there would be occasions when the highway must necessarily be routed in a way which would not permit of connecting it directly with one or more county seats, and, therefore, with that thought in mind, it was provided that there should be "such branch roads as may be necessary to connect therewith the several county seats lying east and west of such state highway."

WITHIN DISCRETION OF ENGINEERING DEPARTMENT.

Therefore, in answer to your first question, I am of the opinion that the Department of Engineering may, in the exercise of its discretion, route the main highway, which I may term the valley highway, in such way that it will run either between Hanford and Visalia, connecting them with it by laterals, or through either one of those two county seats, connecting the other therewith by laterals, according as to which route that department considers the most direct and practicable route north and south through that portion of the State.

AS TO CENTERS OF POPULATION.

2. With respect to your second question, as to the construction of the words "centers of population," permit me to say that I do not believe that it was intended to limit that term to the large centers of population such as you have mentioned. The term is used in connection with the term "county seats of the several counties" so that apparently it was intended thereby to cover places other than those which, as county seats, might also be in their respective counties, centers of population; that is to say, places which though not county seats were of considerable importanee and centers of population in their respective counties.

Three Miles of California State Highway Near Marysville, Yuba County, Ready for Surfacing.

MERELY DESCRIPTIVE AND ILLUSTRATIVE.

That term "joining the centers of population" was, in my opinion, intended merely as descriptive of the general purpose of the highway system, illustrative in a measure of the object which the Department of Engineering should have in view in routing the highway. The sense in which the term is used, or the extent to which it shall be carried, is not stated in the statute, but seemingly it must be left as a fact to be determined from existing conditions by the Department of Engineering.

THE DEPARTMENT MUST DETERMINE THE FACT.

Therefore, if in routing such highway by the most direct and practicable route through some county, a plaee in that county, of such magnitude in the sound judgment of the Department of Engineering as to be treated as a center of population thereof to be served by such highway, lay within its general path, then the Department of Engineering

in running such highway, if it determines for itself that such place is such center of population to be so served, may, in the exercise of its discretion, so run such highway, bring it in touch and join it with other centers of population lying along such highway system.

"CENTERS" MAY BE LEFT OFF ALTOGETHER.

It is likewise possible that there may be centers of population lying off from the main highway, but these, in so far as they are not county seats, must either come in touch with the highway system by reason of their being situated upon the laterals connecting the county seats with the main highway, or else if not so situated, they can be no part of the system under the present statute.

NEED NOT BUILD TO ADJACENT STATE LINES.

3. With respect to your third question, as to connecting the county seats of Del Norte and Siskiyou with the state line on the north and the county seats of Imperial and San Diego with the state line on the south, permit me to say that I find nothing in the statute which requires such connections to be made. In so far as there may be centers of population, within the meaning of that term as hereinbefore suggested, lying within the path of said main highways, north of said two northern county seats or south of said two southern county seats, it is within the power of said Department of Engineering to extend said main highways beyond said county seats to said centers of population, but there is nothing in the statute which requires such extensions to be made if the sole object of such extensions is to reach the state lines on the north and the south.

LATERALS FOR COUNTY SEATS ONLY.

4. With respect to your fourth question, permit me to call your attention to the punctuation of the statute which is different from the punctuation of the statute as you have quoted it in your letter. In the statute there is a comma after the word "population," and the clause "joining the centers of population" is coupled by the word "and" with that which immediately precedes it with reference to connecting the county seats of the several counties. The balance of the paragraph seemingly stands alone and as it reads requires the construction of such branch roads as may be necessary to connect with the highway system the several county seats lying east and west of that main highway that is nearest, of course by the most direct and practicable routes, to such county seats.

THE MAIN DESIDERATUM.

The answer to your fourth question will be found in what I have said in the forepart of this opinion in discussing the general scope of the act, and in what I have said in my answer to your third question. But to repeat the same, let me say again that in my opinion the main desideratum is a general highway system, the routes of which shall be most direct and practicable, and that it should be the aim of the Department of Engineering in determining such route or routes of such system, when it shall have determined the most direct and practicable route, to run the highway in such manner that without sacrificing directness and practicability of routes the county seats of the several counties through which it passes may be connected and the centers of population joined, and that, when in so running the highway by a direct and practicable route that aim cannot be accomplished, there shall then be constructed such branch roads as may be necessary to connect with such highway the several county seats lying east and west of such highway and nearest thereto by the most direct and practicable routes.

Very truly yours, U. S. WEBB, Attorney General,
By ROBERT W. HARRISON, Deputy.

Building the State Highway Near Burlingame, San Mateo County.

Work on the State Highway Near Burlingame, San Mateo County.

The Engineering Department

As provided by the amended statutes, the Department of Engineering of the State of California consists of an Advisory Board of seven members, composed of the Governor as ex officio member and chairman, the State Engineer, Superintendent of State Hospitals, Chairman of the State Board of Harbor Commissioners of San Francisco, and three other members to be appointed by the Governor.

The intent of the law in providing that the Governor should appoint three members of the Advisory Board of the Department of Engineering was to give the Chief Executive freedom in selecting a board into whose hands he could especially place the execution of the eighteen million dollar highway trust.

In accordance therewith, the Advisory Board of the Department of Engineering of the State of California met in the Governor's office on the eighth day of August, 1911, at which the following were present:

Hon. Hiram W. Johnson, Governor.

Mr. Nat. Ellery, then State Engineer.

Mr. J. J. Dwyer, Chairman of the Board of Harbor Commissioners of San Francisco.

Dr. F. W. Hatch, General Superintendent of Hospitals.

Mr. Burton A. Towne, of Lodi, appointed member.

Mr. Charles D. Blaney, of Saratoga, appointed member.

Mr. N. D. Darlington, of Los Angeles, appointed member.

At this meeting, the Advisory Board adopted the following resolution, designating the three appointed members as a committee to be known as the California Highway Commission:

Resolved, That the appointed members of this board, to wit, Messrs. Charles .D Blaney, Burton A. Towne, and N. D. Darlington, be and they are hereby appointed a committee, to be known and designated as the "California Highway Commission," with the jurisdiction and powers following, to wit:

(1) To take full charge of the entire matter of the construction and acquisition of a system of state highways in and for the State, as and in the manner provided by law, at a cost not to exceed the sum of $18,000,000, under and in pursuance of the act of the Legislature of the State of California approved March 22, 1909, and known as the State Highway Act, and to do and perform as fully and completely as may be done by any part, or representative, or committee of this Advisory Board, every act and thing that may be requisite to be done and performed in connection with the highways of the State of California, or that ought to be done and performed under the said State Highway Act.

(2) To do and perform every act and thing in and about the premises that a committee of this Board may be lawfully authorized to do for or on behalf of this Board; and to have full charge and control of the acquisition and construction, of the laying out and the building of a system of such highways.

(3) To report from time to time to this Board their actions and proceedings and to submit to this Board for determination such matters as the law requires this Board to act upon; and to superintend the work and operations of the Highway Engineer whose appointment is provided for by the act of the Legislature of the State of California, approved April 8, 1911.

(4) To perfect such organization as they may deem necessary to carry on with celerity and efficiency the work to be done in the matter of the acquisition and construction of the said system of state highways, and under said State Highway Act; and generally to do all and singular every act and thing that may be necessary for the due, speedy and efficient performance of all that may be required under the said State Highway Act, and under said act of the Legislature of the State of California approved April 8, 1911.

By the foregoing, it will be seen that the California Highway Commission is an executive committee to which is delegated all the powers and functions of the Advisory Board of the Department of Engineering, permissible under the law and necessary to the work of constructing the state highway under the State Highways Act.

While the Advisory Board has reserved the right to place its final seal of approval upon the proceedings of the Commission, and while the Commission scrupulously submits all its official acts to the Advisory Board for such ratification, this control on the part of the Advisory Board has always been exercised in the spirit and intent of the above stated enabling resolution which places the responsibility of the state highway undertaking upon the three appointed members and the Highway Engineer.

COUNTIES PROVIDE RIGHTS OF WAY AND BRIDGES

Boards of Supervisors are Helping to Build the State Highway

Under date of February 19, 1912, the California Highway Commission addressed the following self-explanatory letter to the various Boards of Supervisors throughout the State:

SACRAMENTO, February 19, 1912.

To the Honorable, the Board of Supervisors of the County of Merced.

GENTLEMEN: A number of counties of the State, through their representatives among whom were many supervisors, have voluntarily offered to provide free rights of way and to build all bridges necessary for such state highway or highways as may be located within their respective limits.

It is apparent that the bond issue of $18,000.000 is inadequate for the great work projected, and the Commission believe that each county which may be benefited by the routing of the state highway system through its territory will be ready to do its part in making the state highway undertaking an unqualified success.

The Commission consider it to be the proper time, while surveys are being ordered and estimates prepared, to have official action taken indicating the disposition of the several counties in this behalf, and it is desired to have offers of free rights of way and bridges by the counties embodied in formal resolutions by their governing boards.

Accordingly, the Commission request your honorable board to consider this important matter at once and trust that you will adopt a resolution agreeing to furnish to the State of California free rights of way and to build necessary bridges for such state highway or highways as may be located in your county.

After you have taken action, please transmit to the Commission a certified copy of your resolution.

Very respectfully,

CALIFORNIA HIGHWAY COMMISSION,
By W. R. ELLIS, Secretary.

Pismo Beach, San Luis Obispo County. On Route of State Highway.

The response from the counties to this appeal for their coöperation has been prompt and most encouraging.

The routes of the two main highways may now be considered practically determined upon. The central or valley highway, as proposed, traverses about twenty counties, the coast route about sixteen counties. Eventually the remaining twenty-two counties will be connected by laterals, surveys for some of which have already been ordered.

Of the thirty-five counties on the direct route of these main highways, only two evince any disposition to be reluctant in pledging to procure the rights of way and construct the necessary bridges in their respective jurisdictions, free of cost to the State. It is unnecessary to state that in these dilatory counties the Commission has not yet started any highway construction work.

Of the twenty-two counties that will necessarily be reached by laterals, twelve have already filed with this Commission, through the formal action of their boards of supervisors, unconditional pledges to procure the rights of way and to build the bridges for the highway in their respective districts without cost to the State.

Several of these tardy lateral counties have signified their intention to take favorable action in this matter at an early date.

Herewith is reproduced in full the certified copy of Merced County's resolution, which is in form similar to most of the pledges made as to rights of way and bridges by the various counties.

IN BOARD OF SUPERVISORS, MERCED COUNTY, STATE OF CALIFORNIA.
September 17, 1912.

Present: Supervisors T. H. Scandrett (chairman), J. R. Boxter, H. G. Peck, George H. Whitworth and C. S. Cothran.

Absent: None.

In the matter of the California State Highway.

The following resolution is presented to the board and adopted:

WHEREAS the California Highway Commission has requested that this Board of Supervisors agree to grant to the State of California the rights of way and to construct the bridges necessary in laying out and constructing in this county the roads provided for in the highway act of 1909; and

WHEREAS the Board of Supervisors realize that the bond issue provided by said act is inadequate to the great work projected; and

WHEREAS this county desires to coöperate with other counties in assisting the state authorities in the completion of the best possible system of state highways, and to be joined therewith; therefore, be it

Resolved, That the Board of Supervisors hereby agrees to obtain all rights of way and to build and construct all required bridges for the state highway where located by the Highway Commission of the State of California in and through Merced County, free of cost to the State of California.

STATE OF CALIFORNIA, } ss.
County of Merced. }

I. P. J. Thornton, county clerk and ex officio clerk of the Superior Court of Merced County, State of California, do hereby certify that the foregoing is a true and correct copy of a resolution passed by the Board of Supervisors of said county at their regular meeting on September 17, 1912, and that the same is now of record in my office.

In witness whereof, I have hereunto set my hand and affixed the seal of said Board of Supervisors, this twentieth day of September, A. D. 1912.

P. J. THORNTON,
County Clerk and ex officio Clerk of the Superior Court,
Merced County, California.

It would, indeed, be difficult to adequately appraise the value of this "team work" of the counties in thus relieving the Commission of the burden of clearing up titles to rights of way and getting deeds therefor. Local people can always best and easiest take care of the local difficulties that such an undertaking involves.

If there is a possibility to make the $18,000,000 highway fund come anywhere near covering the cost of the proposed state system, it will only be by dint of the most economical management, reinforced by the energetic and effective coöperation of the county governments in thus relieving the State of the burden of procuring rights of way and building the bridges.

Progress of the State Highway in Yuba

The Natomas Consolidated is filling an order placed by Contractor Frey, who is building a ten-mile strip of the state highway from Marysville southward, of 24,000 tons of crushed rock. The first shipment of the material was made August 5, 1912. Up to the present time, something over 7,225 tons have been delivered.

Contractor Frey has graded over eight of the ten miles which he has contracted to construct, and at this time has about three miles covered with rock, leveled and rolled, ready to be surfaced with oil and screenings, as shown in the picture on page six.

Other views taken on this piece of work are found on page ten.

EMPLOYEES APPOINTED SOLELY ON MERIT

Applying Business Methods to a Great Public Work

It would naturally appear that the expenditure of $18,000,000.00 in the construction of twenty-five hundred miles of public roads would require the direct employment by the State of an army of thousands. This is not necessarily the case, however.

The long-pursued policy of the State has been to contract for the construction of its public works and buildings.

While the California Highway Commission has not committed itself to this method, all work under the Highways Act thus far started has been let to the lowest responsible bidders. It is obvious, therefore, that the vastly greater portion of the labor employed on the state highway is hired by these bidders.

On the pay roll of the Commission for the month of September, 1912, there were three hundred and six persons, classified as follows:

	Headquarters.	I.	II.	III.	IV.	V.	VI.	VII.	Total.
Secretary	1	--	--	--	--	--	--	--	1
Assistant Secretary	1	--	--	--	--	--	--	--	1
Assistant Highway Engineer	1	--	--	--	--	--	--	--	1
Division Engineers	--	1	1	1	1	1	1	1	7
Principal Assistant Engineer	--	1	1	1	1	1	1	1	7
Attorney	1	--	--	--	--	--	--	--	1
Office Engineer	1	--	--	--	--	--	--	--	1
Resident Engineers	--	1	--	1	1	--	1	1	5
Assistant Resident Engineers	--	1	--	--	1	--	--	--	2
Chief Accountant	1	--	--	--	--	--	--	--	1
Clerks	2	1	1	1	1	1	1	1	9
Stenographers	5	--	--	--	1	1	1	1	9
Typists	1	--	--	--	--	--	--	--	1
Messenger	1	--	--	--	--	--	--	--	1
Geologist	1	--	--	--	--	--	--	--	1
Testing Engineer	1	--	--	--	--	--	--	--	1
Draftsmen and Computers	4	4	5	6	6	11	4	7	47
Chiefs of Party	--	5	5	4	4	6	3	6	33
Instrument Men	--	3	4	3	5	7	3	6	31
Rodmen	--	11	8	7	13	14	8	12	73
Axmen	--	7	3	3	5	4	--	1	23
Timekeeper	--	1	--	--	--	--	--	--	1
Levelers	--	1	--	--	1	--	--	--	2
Stakeman	--	1	--	--	--	--	--	--	1
Chainman	--	1	--	--	--	--	--	--	1
Janitor	--	--	--	--	--	1	--	--	1
Teamsters	--	3	3	--	2	4	--	6	18
Cooks	--	5	6	--	--	5	2	8	26
Totals	21	47	37	27	42	56	25	51	306

From the above table, it will be observed that two hundred and seven of the employees are engineers, surveyors and draftsmen; twenty-three are classified as clerical; of axmen, teamsters, and cooks, there are sixty-seven. But even these last mentioned are not to be considered as common laborers. Aside from sobriety and physical and moral fitness, it takes considerable experience to serve a surveying crew satisfactorily as axman, teamster or cook.

Therefore, it may be truly stated that among the limited number of positions available under the Commission, there are practically no positions for untrained and unskilled people.

At the outset, the California Highway Commission determined that competency, ability, and character should be the prime qualifications that should govern in the organization of its office and field forces.

If the State is to be permitted to do its own business in a businesslike way, it must adopt those ordinary, practical business methods that are everywhere recognized in the business world as the prerequisites of efficiency and success. To avail itself of the best technical skill that the State's money can procure has been consistently the aim of the Commission, and this spirit has bred into the individual member of the organization a certain pride in his employment which challenges him to give his best to the State.

As against the man who imagines he receives his appointment by grace of a political pull or as a reward for services to the party, one who wins preference on the showing of his special training, experience and personal worth will ordinarily apply himself with greater zeal and interest to his work, since he realizes that he has been taken upon his own merits and that his career in the department will be made or marred alone by his own conduct.

In a work such as this Commission is charged with, it is peculiarly important that its forces not only possess the proper skill and training, but what is rarer, the heart interest which stimulates each individual to earnest and conscientious endeavor in the discharge of his duties.

By the process of "finishing" with laggards and derelicts, and of advancing those who prove their fitness to fill vacancies higher up in the service, the Commission, under the generalship of the Highway Engineer, has assembled a loyal, earnest body of employees with whom it is an honor to be associated.

There are at present approximately twelve hundred formal applications for employment on file with the Commission, and the list grows daily.

The applicant, in filling out this blank, states the date and place of his birth, where educated, what positions he has held during the past ten years, the salaries he received in such previous employment, when he left his last position and for what reasons, whether he has any disqualifying defect in body or mind, and references with post office addresses.

Reinforced Concrete Bridge Over San Luis Rey River. Length, 690 Feet. Built by San Diego County Highway Commission. On Route of State Highway.

When such an application is received, it is classified according to the character of the employment sought, and indexed. A letter accompanied by a return report form and a return addressed and stamped envelope is sent out to each of the persons named as references. When these reports are received, they are attached to the application and it is filed for consideration.

The great majority of those to whom these reference blanks are sent forward their reports promptly and with evident candor. Sometimes an applicant gives names as references without any expectation that the persons referred to will be called upon to testify in his behalf.

When the report comes in, perhaps it will read "Never heard of the party mentioned," or worse, "So and So worked for this company in 1909 and was discharged for negligence and dissipation."

As new men are needed, because of the expansion of the Commission's work or to fill vacancies that occur for various reasons, the force is recruited from those whose applications are on file. When from five to fifty good men are in line for a job, and there is only one place open, it is simply a case of the Highway Engineer's recommending the one who seems best to answer the requirements.

In all cases where the positions are of the more responsible character, requiring technical training, the applicant is usually invited to a personal interview with either the Highway Engineer or one of the Division Engineers before he is recommended for employment.

The new government of the city of Sacramento at the outset adopted a system of formal applications for employment, copied after that of this Commission. Other important departments of the State have recently taken up the study of the Highway Commission's method along this line with serious intent to apply the same progressive principles to their organization. This is in line with the efforts of all the best influences that have always been at work in the political life of the State and Nation, seeking to apply to the public's business the same efficiency and honesty in management that is necessary to the success of any private undertaking.

Making Reinforced Concrete Culvert on State Highway Near Marysville.

Where the Money Goes

Hon. E. D. Roberts, State Treasurer, has sold state highway bonds as follows: On October 21, 1911, $400,000 and on July 11, 1912, $1,200,000, making a total of $1,600,000. From the General Emergency Fund the Commission had received prior to the sale of these bonds, $731.30.

The State Treasurer reports on October 9, 1912, that there remains to the credit of the highway fund in his hands the sum of $1,263,742.93.

The amount, therefore, expended by the Commission during the little more than a year of its existence is $336,257.00 plus the $731.30, or $336,988.57.

In subsequent numbers of the Bulletin detailed financial statements of the receipts and disbursements of the Commission will be published.

Approximately the following tabulation will show for what purposes the money thus far has been paid out:

Headquarters, equipment	$8,746 82	
Headquarters, salaries	17,986 20	
Headquarters, personal expenses, officers	4,229 06	
Headquarters, miscellaneous expenses, rent, etc.	17,080 38	
Headquarters, paid contractors, for construction work	33,229 92	
Headquarters, office fund	100 00	$81,372 38
Seven divisions, equipment	$50,942 99	
Seven divisions, salaries	136,960 67	
Seven divisions, personal expenses, officers	6,025 13	
Seven divisions, miscellaneous expenses, provisions, etc.	61,687 20	$255,615 99
Total expenditures		$336,988 37

The past year has been one of organization and necessary preliminary work.

The work of the architect is fairly well completed; the foundations are laid; the raising of the structure has begun. Before the end of 1913 hundreds of miles of the state highway system will be completed and thrown open to the public.

It will be the business of the Bulletin to keep the public promptly posted as to the progress of this work.

Geological and Laboratory Department

The Highway Commission has a physical and chemical testing laboratory located on the State Fair Grounds in Sacramento. This laboratory is equipped to test road metal, gravel, sand, asphalt, road oil and cement. As far as possible the Commission has adopted the specifications of the American Society of Civil Engineers and the American Society for the Testing of Materials for all tests. Tests of road metal, asphalt and road oil are made to conform to the methods used in the laboratory of the Office of Good Roads, Department of Agriculture, Washington, D. C.

The hardness and toughness of road metal is determined by the abrasion method (Deval type). The percentage of absorption and specific gravity is also determined.

Sand and gravel are tested by sieving to determine the grading; also for the percentage of voids. The sand is mixed with Portland cement in a 1–3 mortar, and the tensile strength of this is compared to the strength of mortar made with standard sand.

Road oil is tested for volatility, flash, viscosity, adhesiveness, percentage of asphaltum and percentage of water and foreign matter.

Asphaltum is tested for solubility in carbon tetrachloride, 86 naphtha and in carbon bisulphide. The penetration, the percentage of volatile material, and the amount of free carbon are determined.

Portland cement is tested according to the specifications adopted by the American Society of Civil Engineers.

The testing laboratory is in charge of a member of the American Society for the Testing of Materials. He has had years of experience in testing road materials.

An examination is made of all available deposits of road metal, gravel, sand, or other material suitable for the highway construction. The Geologist's report on these materials contains the following information:

The location of the deposit.
The transportation facilities from the deposit to the point of use.
The equipment and method of handling the material.
The average daily production.
The approximate amount of material available.
The action of the material where it has been used.
The uniformity of the deposit and the methods used to prevent foreign or poor material being included in the output.
In addition, samples are taken for the laboratory test.

Building the State Highway Near Marysville.

San Luis Starts Condemnation Proceedings

The Supervisors of San Luis Obispo County are setting the pace for other boards of supervisors in their aggressive action to obtain the necessary rights of way for the state highway through their county. They have directed the District Attorney to bring condemnation proceedings against certain landowners who refuse to make reasonable terms in the matter of giving deeds for these rights of way through their lands. Further, they have called formally upon the County Surveyor to lend the District Attorney all required assistance in the matter.

It is obvious that, whether a house is to be built or a public road constructed, the very first thing to attend to is to get a good and sufficient deed to the land that it will occupy.

San Luis Obispo is nobly doing its best to facilitate the work of the State in highway matters. Many other counties are showing the same commendable spirit.

ONE THOUSAND MILES OF HIGHWAY SURVEYED

First Year's Work of the Commission Graphically Reviewed

Early in its work the Commission chose certain main routes as follows:

Route 1.	San Francisco to Oregon line	421 miles
Route 2.	San Francisco to San Diego via Los Angeles	592 miles
Route 3.	Sacramento to Oregon via east side Redding	344 miles
Route 4.	Sacramento to Los Angeles via San Joaquin Valley	445 miles
Route 5.	Stockton to Santa Cruz via Oakland	133 miles
Route 6.	Sacramento to Woodland Junction	20 miles
Route 7.	Tehama to Benicia	191 miles
Route 8.	Hopland to Vallejo via Lake County	107 miles
Route 9.	Los Angeles to Riverside	46 miles

The aggregate length of these routes is approximately 2,300 miles. Surveys were started in February, and the plans and estimates pushed forward as rapidly as consistent with good work. As the work advanced the several routes were subdivided within the counties into sections of convenient lengths. A number of these sections are already under contract and the building has begun.

The type of construction and the width of roadway for the different sections vary considerably to meet local conditions. Near San Francisco, where the traffic is extremely heavy, provision has been made for sheet asphalt pavement 24 feet wide with sufficient earth shoulders on either side; but in some of the mountainous districts roads are to be graded but eighteen feet wide, and they will not be paved. The usual width of pavement will be fifteen feet and the minimum width of shoulders on either side, three feet.

Following is a table showing the status of the work on the several routes by counties:

Route 1.

Marin. Sec. A. Survey complete. Sec. B. Survey nearly complete.

Sonoma. Sec. B. Laid out as state highway September 25, 1912. Now advertised for contract. Length 13.7 miles. Pavement, oiled concrete 15 feet wide. Sec. A. Surveys complete. Sec. C. Survey nearly complete.

Mendocino. Sec. A. Laid out as state highway May 21, 1912. Contract awarded July 23, 1912, to the General Contracting Corporation. Length 12.8 miles. Road to be graded but not paved. Probable total cost $69,900. Probable cost per mile $5,460. Secs. B, C, D and E. Surveys complete. Willits to Humboldt County line, surveys begun.

Humboldt. Surveys begun.

Route 2.

San Mateo. Sec. A. Laid out as a state highway May 21, 1912. Contract awarded July 23, 1912, to F. R. Ritchie & Co. Length 5.4 miles. Sheet asphalt 24 feet wide on concrete base. Probable total cost $92,180. Probable cost per mile $17,070. Sec. B. Survey complete.

Santa Clara. Sec. A. Laid out as a state highway July 23, 1912. Part 1. Length 6.4 miles. Sheet asphalt 20 feet wide on macadam base. Part 2. Length 5.5 miles. Oiled concrete 20 feet wide. Both parts of Sec. A are advertised for contract. Secs. B and C. Surveys complete.

San Benito. Surveys nearly complete.

Monterey. Surveys complete.

San Luis Obispo. Surveys complete.

Santa Barbara. Secs. A, B, C, E, and F. Surveys complete. Secs. D and G. Being surveyed. Sec. H. Built by county.

Ventura. Sec. F. Laid out as a state highway August 27, 1912. Length 4.4 miles. This section includes a long timber trestle partially built. The State has taken over the completing of the trestle. Secs. A, B, C, D and E. Surveys practically complete.

Los Angeles. Sec. A. Laid out as a state highway September 25, 1912. Now advertised for contract. Length 6.6 miles. Oiled concrete 15 feet wide. Secs. B and C. Survey complete.

Orange. Surveys nearly complete.

San Diego. Sec. A. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to M. L. Curtis & Co. Length 8.4 miles. Oiled concrete 15 feet wide. Probable total cost $69,710. Proable cost per mile $8,300. Secs. B, C and D. Surveys complete.

Route 3.

Sacramento. Sec. A. Laid out as a state highway August 27, 1912. Contract awarded September 25, 1912, to Burns, Clark & Da Roza. Length 1.8 miles. Oiled concrete 15 feet wide. Probable total cost $13,700. Probable cost per mile $7,615.

Placer. Sec. A. Laid out as a state highway August 27, 1912. Contract awarded September 25, 1912, to Burns, Clark & Da Roza. Length 9.9 miles. Oiled concrete 15 feet wide. Probable total cost $84,950. Probable cost per mile $8,580. Sec. B. Surveys complete.

Yuba. Sec. B. Laid out as a state highway May 21, 1912. Contract awarded July 23, 1912, to F. E. Frey. Length 8.9 miles. Oiled macadam 15 feet wide. Probable total cost $70,930. Probable cost per mile $7,970. Sec. A. Surveys nearly complete.

Sutter. Sec. A. Survey complete.

Butte. Secs. B, C and D. Surveys complete. Sec. A. Survey in progress.

Tehama. Secs. A and C. Surveys complete. Sec. B. Survey nearly complete.

Shasta. Sec. B. Survey complete. Secs. C and D. Surveys begun. Sec. A. Survey not started.

Siskiyou. Sec. A. Survey nearly complete. Sec. B. Survey begun.

Route 4.

Sacramento. Built by the county.

San Joaquin. Built by the county.

Stanislaus. Sec. A. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to E. O. Burge. Length 11.1 miles. Oiled concrete 15 feet wide. Probable cost, total, $81,800. Probable cost per mile $7,370. Sec. B. Survey complete.

Merced. Sec. C. Laid out as a state highway August 27, 1912. Contract awarded September 25, 1912, to the Worswick Street Paving Co. Length 10.9 miles. Oiled concrete 15 feet. Probable total cost $85,950. Probable cost per mile $7,885. Sec. D. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to the Worswick Street Paving Co. Length 9.6 miles. Oiled concrete 15 feet wide. Probable cost, total, $73,260. Probable cost per mile, $7,630. Sec. A. Surveys complete.

Madera. Entire county under contract. Sec. A. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to the Worswick Paving Company. Length 9.9 miles. Oiled concrete 15 feet wide. Probable cost $69,050. Probable cost per mile $6,975. Sec. B. Laid out as a state highway May 21, 1912. Contract awarded July 23, 1912, to Ransome-Crummey Company. Length 10.0 miles. Oiled macadam 15 feet wide. Probable total cost $74,750. Probable cost per mile $7,425. Sec. C. Laid out as a state highway July 23, 1912 Contract awarded August 27, 1912, to Worswick Street Paving Company. Length 6.8 miles. Oiled concrete 15 feet. Probable total cost $47,970. Probable cost per mile $7,055.

Fresno. Sec. C. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to the Worswick Street Paving Company. Length 9.6 miles. Oiled concrete 15 feet wide. Probable total cost $64,810. Probable cost per mile, $6,750. Secs. A and B. Surveys complete.

Tulare. Sec. D. Survey complete. Secs. A, B, C and E. Not started.

Kings. Sec. A. Survey complete.

Kern. Secs. D, E and F. Surveys complete. Secs. A and C. Surveys progressing. Sec. B. Survey not started.

Los Angeles. Secs. A, B, C and D. Surveys in progress.

Route 5.

San Joaquin. Built by the county.

Alameda. Sec. C. Survey complete. Sec. A. Survey in progress. Sec. B. Survey not begun.

Santa Clara. Sec. A. Survey complete. Sec. B. Survey not begun.

Santa Cruz. Sec. A. Survey complete.

Route 6.

Yolo. Sec. A. Survey begun.

Route 7.

Yolo. Secs. B and C. Surveys complete. Sec. A. Survey not started.

Colusa. Secs. A, B and C. Surveys complete.

Glenn. Secs. A, B and C. Surveys complete.

Tehama. Sec. A. Survey complete.

Route 8.

Surveys not begun.

Route 9.

Surveys not begun.

SUMMARY.

Upwards of 1,000 miles have been surveyed and practically 152 miles of road have been laid out as State highway. Of this mileage 115 are now under contract and 32 miles are advertised for contract. The pavement for the roads which have already been laid out may be classed as follows:

Sheet asphalt on concrete base	5.4 miles
Sheet asphalt on macadam base	6.4 miles
Hydraulic concrete with oiled surface	103.9 miles
Macadam with oiled surface	18.0 miles
Grading (no pavement)	12.8 miles
Miscellaneous	4.4 miles
Total	151.8 miles

A STATEMENT FROM THE HIGHWAY ENGINEER

Comments on the Municipal League Committee's Report

To the Califarnia Highway Commissian.

GENTLEMEN: Agreeably to your request for my opinions I make the following comments on the report of the Committee of the League of California Municipalities dated August 22, 1912, and presented to the League at its convention held at Berkeley during the last week of September.

I have been informed by one of the members of the committee that it was their intention that the report should be a friendly criticism of the work so far undertaken by the Commission and, notwithstanding the publication of the report in the newspapers more than a month in advance of its submission to the League, I am compelled to believe that the committee intended to be helpful rather than inimical.

Naturally, their comments on the good judgment of the Commission in its choice of routes and upon the efficiency of its engineers in the surveying work is gratifying and I can find no fault with that portion of their report.

They devote considerable space to quotations from my paper read August 5, 1912, before the Pacific Highway Association at San Francisco and later in their report they infer that the "oil macadam" type of pavement will be made more or less of a standard throughout the state and indicate their disapproval of that type of pavement.

I cannot concur in their utter disapproval of "oil macadam," for I believe that when properly constructed it is worthy of recognition as a pavement for rural highways, but they are not warranted in assuming that that type is contemplated as a general "standard" for the state highways of California, and I regret that in my San Francisco paper I left an opportunity for such an assumption.

Had the committee found time to discuss the plans of the Commission with me, I could have made clear to them that and some other points about which they are apparently misinformed.

SPECIFIC CRITICISMS IN REPORT.

Thin Asphalt Wearing Surface, San Mateo.

The reporters object to the sheet asphalt wearing surface specified for the road in San Mateo County between South San Francisco and Burlingame, saying that "a one-inch wearing surface seems to be much too thin, and not in accordance with modern paving practice."

It is true that one and one half inches of sheet asphalt is the minimum thickness usually specified for city street work and that the San Mateo work is somewhat of a departure. I believe, however, that for the rural road there contemplated, the thin wearing surface will last many years. My opinion is confirmed by a number of asphalt workers who were consulted and by my observation of sheet asphalt streets where by accident the surface is much thinner than the specifications intended.

Cancrete Base Wark.

The reporters call attention to the difficulty of securing good concrete under adverse conditions on highway work where "water and transportation facilities are not convenient," and call such a base, no matter what its thickness, an impracticable structure, but in their suggested specifications — somewhat inconsistently — they devote two paragraphs to their recommendations for concrete bases with different wearing surfaces, and earlier in their report they approve the concrete base for the San Mateo road.

I agree that a concrete base, of whatever thickness, must be put down with the greatest of care and must be properly protected at every stage of the operation until it has received the wearing surface; but that the engineers and contractors of California cannot secure good hydraulic concrete work, and at a reasonable cost, is an unwarranted assumption even if the conditions be adverse.

On some 78 or more miles of state highway under contract, a concrete base 4 inches thick has been specified. This must be considered as a minimum thickness only. The unit contract prices are based upon cubic yard measurement, and it is intended to increase the thickness of the concrete base whenever it is not possible to secure an adequate subgrade. On the 78 miles under contract, however, the subgrade is for the most part satisfactory for the minimum 4-inch concrete base. It should also be remembered that the concrete specified is a much richer mixture than is customarily used for pavement bases.

Mastic Wearing Caurse — Bituminaus Taps.

In the early specifications bids were asked for a wearing surface of mastic (a composition of asphaltic cement, finely powdered limestone and stone screenings), but the bids received were so high that no work of that nature was contracted for. It is, however, proposed to do enough of this work by "force account" to demonstrate its value and to secure accurate cost data. In my opinion there is much merit in this type of wearing surface.

Instead of the mastic, the contracts provide for a wearing surface composed of a rich asphaltic road oil and stone screenings — a protective coat from ⅜ inch to ½ inch in thickness. Such work ought to be done under California conditions for 5 cents or less per square yard. This protective coat, under the present traffic on the rural highways, should last from two to three years, if precedent under far more adverse conditions in other parts of the country is worth considering. Hundreds of miles of water-bound macadam have been maintained by this process since the year 1906 in Eastern States, and my recent inspection of these roads has reinforced my belief in the efficacy of the treatment. If, under the rain, snow, and frost conditions, which obtain there, the oil protective cost is successful, it is unbelievable that similar wearing surfaces on top of comparatively clean, hydraulic cement concrete bases, with a far better grade of oil than that used in the East and with the benign climate of this State will not be equally satisfactory as regards cost and quality.

COSTS.

The reporters advocate the asphaltic concrete type of pavement for general use, and I agree that it is an excellent pavement, although I prefer a road with a hydraulic cement concrete base to one consisting wholly of bituminous concrete.

The lowest price quoted by the reporters for asphaltic concrete, 5 inch work, in Sacramento, is 11 cents per square foot, including grading. A similar work in Fresno has cost 15 cents, and in Madera 14 cents per square foot, they say. It is fair to remark that these costs are low, and that from 15 cents to 17 cents per square foot would more nearly approximate the going rate for this class of work.

The tabulation below indicates what will be the probable costs of the 78 miles of "oiled concrete" already contracted for by the Commission. In the compilation the costs of bridges, culverts, drainpipes, guard rails, and other miscellaneous items, always needed in rural work, are omitted for purposes of comparing costs with the figures for asphaltic concrete above quoted. In the table the inclusion of all of the grading costs on the state highways is unfair, in that it includes a much greater width than the width of the paving, while the grading costs applying to the costs of asphaltic concrete quoted are only for the width actually paved.

ESTIMATED COST OF "OILED CONCRETE" ROADS, OCTOBER 1, 1912.

Number. Contract	County.	Route.	Section.	Length.	Contractor's bid plus 3 per cent.	Materials furnished by the state plus 3 per cent.	Total.	Culverts and miscellaneous plus 3 per cent.	Estimated cost of grading and paving.		
									Per mile.	Per square yard.	Per square foot.
5	Stanislaus	4	A	11.07	$59,042	$22,763	$81,805	$49	$7,381	$0 839	$0 093
6	Merced	4	D	9.61	51,854	21,408	73,262	742	7,546	0 858	0 095
7	San Diego	2	A	8.43	50,918	18,792	69,710	1,741	8,062	0 916	0 102
8	Fresno	4	C	9.56	43,537	21,279	64,816	197	6,759	0 768	0 085
9	Madera	4	A	9.94	46,924	22,127	69,051	261	6,921	0 786	0 087
10	Madera	4	C	6.82	32,786	15,186	47,972	491	6,962	0 791	0 088
11	Mereed	4	C	10.89	59,322	26,631	85,953	4,111	7,518	0 854	0 095
12	Saeramento	3	A	1.84	9,434	4,274	13,708	325	7,273	0 826	0 092
13	Plaeer	3	A	9.93	61,418	23,537	84,955	4,139	8,139	0 925	0 103
	Total			78.09	$415,235	$175,997	$591,232	$12,056			
	Average								$7,417	$0 843	$0 094

The error, however, is doubtless partially offset by the admitted higher cost of grading under the urban conditions where the asphaltic concrete work was done.

It will be noted in the foregoing table that the average cost per square yard for the work is $0.843. Doubtless this is higher than it should be, and there are indications that as the contractors become familiar with the work the price will be reduced.

The typical state highway as planned is paved to a width of 15 feet, and there are therefore 8,800 square yards of pavement to the mile.

At the average price per square yard as shown in the table, the average cost of grading and paving the typical state highway will be $7,417 per mile on the "oiled concrete" basis.

Taking 14 cents per square foot ($1.26 per square yard) as being about the average of the costs for asphaltic concrete quoted by the reporters, the typical state highway would cost $11,088 per mile for grading and paving with asphaltic concrete, or $3,671 per mile more than the "oiled concrete" will cost. The asphaltic oil protection top

A Mountain Grade on the State Highway, Between Cloverdale and Hopland in Mendocino County.

can be replaced at any time after it has worn so as to require renewal at not to exceed 5 cents per square yard, and under any traffic which I can foresee on any of the roads already contracted for, a treatment will last two years at least and perhaps three years. If it lasts two years the annual cost of restoring the surface will not exceed 2½ cents per square yard per year or $220 per mile per year; if three years, $146.67 year per mile.

As already stated, the difference between the first costs of the two types is $3,671 per mile and at 4 per cent interest, the asphaltic concrete road costs $147 per mile per year more for interest charges than does the "oiled concrete." If, therefore, the oil coat lasts three years the cheaper type of paving may be kept in repair for the amount the more expensive road costs per annum for interest.

I submit that on the foregoing basis the "oiled concrete" road merits serious consideration as a standard for the California state highways, but the showing is vastly in its favor if the asphaltic concrete type or the sheet asphalt type of pavement are charged with their proper maintenance costs.

The idea somewhat generally prevailing that the latter kinds of pavement require no expense for maintenance is a fallacy. Asphaltic concrete and even the best pavement of this type known as the "bitulithic" pavement, if kept in the best of condition, require paint coats or "squeegee" coats of bitumen after a few years of use, at a cost of several cents per square yard. Sheet asphalt, if the experience of the city of Buffalo, N. Y., during more than thirty years is any criterion, costs nearly 4 cents per square yard per annum for repairs and maintenance, overhead charges omitted.

CONCLUSION.

The report of the committee to the League of California Municipalities raises some interesting points, but they touch upon no subject which has not been considered pro and con many times at the executive meetings of the Commission.

I think that the plan adopted of constructing the bases of the roads of hydraulic cement concrete is above adverse criticism. A foundation is thus provided for almost any kind of wearing surface which the future may develop.

The State Highways Act provides that the state shall maintain the roads and by the time the money is needed the Legislature will doubtless appropriate money for that purpose. When the time arrives that a better type of wearing surface seems desirable, it is likely that another bond issue will be voted. A permanent base will be ready to receive it.

The pith of the criticism is that the Commission is trying to do too much work that the committee is pleased to call "mediocre" in an endeavor to complete the state highway system within the sum appropriated, namely, $18,000,000.

The reporters virtually recommend that the requirements of the State Highways Act be disregarded and that the Commission proceed with its work, without particular consideration of the entire mileage, and pave the main lines with either sheet asphalt on a heavy concrete base or with the so-called asphaltic concrete.

Such ultra-substantial work as the committee recommends would be more nearly applicable to the needs of Fifth avenue in New York or the London Embankment, and the rural roads of California will hardly require such heroic treatment, at least during the life of the present bond issue.

Were it desired to build now such costly types of road what justification would an officer of the people have in disregarding the plain mandates of the law and deliberately adopting a policy which would leave out from the system from one quarter to one third of the roads which the people voted to improve.

Who in the State has the power, the right, or the assurance to direct or to even connive at such a policy?

Respectfully, (Signed) A. B. FLETCHER,
Highway Engineer.

October 10, 1912.

Municipal League Committee's Report

Following is the report of the Committee appointed by the League of California Municipalities, to which the Highway Engineer refers, in the foregoing article.

HEADQUARTERS OF THE LEAGUE OF CALIFORNIA MUNICIPALITIES,
SAN FRANCISCO, CALIFORNIA, August 22, 1912.

To the League of California Municipalities, San Francisco, California.

GENTLEMEN: We, your committee appointed at the Santa Barbara convention for the purpose of watching the progress of the work of the State Highway Commission and reporting our findings to your body, beg to submit the following brief report of the progress up to the present time.

PROBLEM BEFORE THE COMMISSION.

The language of the highways act recites: "The route or routes of said state highways shall be selected by the Department of Engineering, and said route shall be so selected and said highways so laid out and constructed or acquired as to constitute a continuous and connected state highway system running north and south through the state, traversing the Sacramento and San Joaquin valleys, and along the Pacific coast by the most direct and practicable routes, connecting the county seats of the several counties through which it passes and joining the centers of population, together with such branch roads as may be necessary to connect therewith the several county seats lying east and west of such state highway." A study of this paragraph will indicate to every one that this phase of the work is by no means easy of fulfillment by the Commission, particularly when the various community factions in practically every county will make every effort to induce the Commission to favor their own particular interests.

We have nothing but the highest commendation for the Commission's choice of

main routes covering a total mileage of approximately 2,300 miles, which added to about 400 miles of lateral bigbways extending out to more or less isolated county seats, will bring the grand total in the neighborhood of 2,700 miles. If the $18,000,000 was to be spread equally over the entire 2,700 miles the cost per mile, including engineering, overhead charges, etc., would be restricted to $6,667 per mile. Every one conversant even in a small degree with road building, will appreciate the fact that good roads of standard designs cannot be constructed for tbat amount of money, and will, therefore, realize at least one of the difficulties confronting the Highway Commission in carrying out the spirit of tbe act itself.

Up to the present time the energy of the Commission has been devoted mainly to surveys, determination of routes and the adoption of specifications for about 100 miles of highway.

We find that the survey work bas been done in a very careful and efficient manner, combining the final survey along with the preliminary work, tbus reducing to a minimum the expenses of engineering work.

As to the quality of roads in general, we will quote from the address of Mr. Austin B. Fletcher, Highway Engineer, read at tbe meeting of the Pacific Highway Association in San Francisco, August 5, 1912: "In brief the standard road which the Commission proposes to build will have the following principal cbaracteristics:

1. A right of way not less tban 60 feet in width wbere it is reasonably possible, and as direct betwecn objective points as is consistently possible.

2. Gradients not exceeding 7 per cent, even in the mountainous parts of the State.

3. Curves as open as possible, and in no case of less than 50 feet in radius.

4. As many culverts of sufficient capacity as are needed to take care of surface and underground water.

5. A traveled way under ordinary conditions not less tban 21 feet in width, and in the mountains not less than 16 feet wide, with the center paved or surfaced so as to be hard and smooth under all climatic conditions at all times of the year, the width of the surfacing to be in general 15 fcet.

6. Smoothly graded roadsides, reserved for future tree planting.

For the main roads of the system the choice for surfacing seems to lie between the so-called oil macadam type and a concrete road with a bituminous surface, the latter being considerably more expensive than tbe former, but much more desirable as concerns quality and permanency. It is evident that neither type can be adopted for general use unless the cost of the materials and the freight charges for transporting them are reduced to the lowest point possible.

It seems apparent that not less than 2,700 miles of the state highway must be built to comply with the provisions of the 'State Highway Act.' Of this mileage it is possible that one third, or 900 miles, will be in the mountains, and will require no surfacing other than local gravel, and that 1,800 miles will have to be surfaced with materials more or less expensive."

"On all the roads now advertised and awaiting contract, it is proposed to use a hydraulic cement concrete base 15 feet wide, covered with a thin surface of bituminous mixture.

Whether or not much additional work of tbis character may be done depends largely upon the cement manufacturers.

It is probable that they will make some reduction in the cement price to induce the Commission to adopt the concrete base for its standard type of construction. Whether the reduction in price will be sufficient to permit of so general a use of concrete is not yet determined."

The sheet asphalt now in course of construction in San Mateo County consists of a 5-inch cement concrete base overlaid with a one-inch thickness of sheet asphalt wearing surface. These specifications for the roads now awaiting the awarding of contracts call for a 4-inch cement concrete base overlaid with a three-eighths inch thickness of asphalt "mastic," the asphalt "mastic" to be composed of between 40 per cent to 60 per cent of asphaltic cement, and the balance of filler.

It can be inferred from the above quotations that the desire and aim of the Commission appears to be to distribute the money value in terms of first cost as equally as possible among all the districts affected and thereby sacrifice, in our estimation, permanency and durability of the pavements.

We would submit that it is our opinion that a better plan of procedure, and one which would also fulfill the requirements of the act, would be that where pavements are constructed at all, they be constructed of a character which is known to be the most durable, permanent and practicable under local conditions; this, of course, would mean that a smaller percentage of paved roads and a greater proportion of graded roads would be constructed than under the present plans. We feel that whatever work is done should be done with the end in view of securing the best pavement known to highway builders to-day, tbus, reducing to the smallest degree possible the factor of future cost of maintenance, for which, by the way, no specific provision has been made to our knowledge. We believe that even though some localities would have to be satisfied with an ordinary graded highway, or perhaps an oil surfaced highway under the present bond issue, this would be a far better course to pursue, not only for the reason that the best pavement is none too good; for the further reason that when the bond issue is exhausted the Commissioners could go before the people and claim that whatever work was done had been done according to the best known construction, and that the graded roads would be finished and could be used as suberades for future pavements if the people would see their way clear to vote an additional bond issue.

There can be no question but that the present bond issue is inadequate to serve all communities with a comparatively permanent pavement, and we believe it far better policy to have good work done as far as can be, than to make an effort to serve all communities by half-way measures. Mediocre or experimental pavements of the character specified can only result, in a very few years at the most, in a roadway which will be extremely expensive to maintain, and probably need reconstruction, but will result in serious reflection upon the ability and foresight of the Commission. If our plans would be carried out, all work done would be of a permanent character, either in completed pavement, or as a material step toward such a completed pavement, and we believe that the matter could be placed before the people in such a manner as to prove to them that the expenditures that were to be made were made to the best advantage, and thus gain their confidence to such an extent that they will be glad to provide the means necessary for the continuance of the good work.

PRESENT SPECIFICATIONS.

Of the specifications for the five and four tenths miles now under course of construction in San Mateo County, we have no criticism to make other than that a one-inch wearing surface seems to be much too thin, and not in accordance with modern paving practice.

In the matter of oil macadam, which, according to Mr. Fletcher's report, will be made more or less of a standard throughout the State with the Highway Commission, we wish to say that it does not meet with our approval. This form of pavement is comparatively new, and has, in fact, not been in use long enough to give us an opportunity of judging of its permanency or durability. Some of our highway pavements laid with oil macadam three or four years ago have resisted disintegration fairly well; perhaps more of them, however, have shown a considerable degree of disintegration and depreciation. Oil macadam constructed by the penetration method cannot be built with sufficient uniformity to prevent more or less disintegration or a soft, spongy surface. If constructed by the mixing method we claim that the additional cost of asphalt over oil would be so immaterial that an asphalt macadam (asphalt concrete) would be far preferable. In tbus reporting adversely with reference to oil macadam pavement tbe very important item of maintenance, which for this pavement will be large, is given consideration.

For this expense, as above mentioned, no provision has yet been made, and which must probably fall upon the various counties in which such pavements lie.

As a commentary on tbe matter of oil macadam, we would call to mind that Los Angeles County alone spent $3,500,000 on oil macadam bigbways, and that in the latter part of 1911, when practically all of the bond issue was spent, the grand jury of the county met and in a final report stated, as we recall tbe words, "tbat the oil macadam roads in Los Angeles County were an absolute failure."

The specifications for work now being advertised include a four-incb cement concrete base (mixed in the proportion of one part of cement, two and one half parts of sand and five parts of gravel or crushed rock), and a mastic wearing surface of from 40 per cent to 60 per cent of asphaltic cement and tbe balance of filler. On highway work where water and transportation facilities are not convenient, we claim tbat a cement base of only four inches in thickness or any other thickness is an impracticable structure; it will be extremely difficult and prohibitive in cost for any contractor to protect the concrete from the sun without covering the same with earth, and it will be even more difficult to keep it wet. We fear that the result will be that the base will crack from the lack of proper moisture and protection, and furthermore we fear that the surface can never be swept or brushed clean enough to enable the asphalt paint coat to be applied in a thoroughly satisfactory manner. Even though boards were used to protect the concrete from the sun, dust will certainly be blown in over the concrete, and thus defeat the proper application of the asphaltic paint coat. Furthermore, as regards the wearing surface, we fear that the high percentage of asphaltic cement will either cause tbe surface to soften and gradually leave the pavement during the hot weather, or, if the penetration is so low that it will not run in hot weather, it will be so stiff as to crack in cold weather, thus allowing water to find its way underneath the wearing surface. The effect then would be that the wearing surface will separate itself from tbe base and rapidly peel off under the continual wear of heavy traffic, and of course it is still an undisputed fact that concrete such as will appear in the specified base will give very little resistance to the effect of general traffic.

We believe that the three eighths inch of mastic wearing surface will not only be very expensive comparatively, but will be much more unsatisfactory than even a one-inch wearing surface or squeegee coat such as is used as a flush coat to finish an asphalt concrete pavement. The amount of asphalt necessary in tbe proposed mastic surface is just the same as would be required in a 2-inch sheet asphalt wearing surface. This surface specification has not been tried out satisfactorily and is therefore an experiment.

It is our belief that, particularly up and down the San Joaquin Valley, motor trucks will come into use immediately upon the completion of the highway for the purpose of transporting freight from terminal points, and tbis factor should be taken into careful consideration before specifications are adopted for such highways. In all other respects, so far as the information has come before us, the plans of work contemplated by tbe Commission are very excellent and worthy of recommendation.

SUGGESTED SPECIFICATIONS.

Having in mind the increasingly greater traffic demands which will be made after tbe completion of the bighway, we would suggest three classes of pavement as being much more permanent and satisfactory in every way than those proposed.

1. A standard pavement, consisting of a cement concrete base, and a bituminous wearing surface of at least two and one half inches thick, constructed according to best modern practice; this form of pavement has been proven to be successful in all large cities and is considered standard by all municipal engineers.

2. A pavement consisting of a 5-inch cement concrete base, as before, but overlaid with a two and one half inch thickness of bituminous rock, similar to many pavements in San Francisco and other cities.

3. A pavement, commonly known as asphalt concrete, consisting of a base course three inches thick and a wearing surface two inches thick, each course to be separately rolled to complete resistance. This form of pavement bas been in use for many years and has proven entirely satisfactory.

A bituminous concrete similar to the asphaltic concrete might be used to advantage along the line of the coast route. For present highway purposes in most localities, we consider that the asphalt concrete form of pavement would be, in all respects, the best pavement to be had under existing circumstances.

In support of our contention that an asphalt concrete pavement can be laid at a comparatively low cost, we would cite that in Sacramento contracts were recently entered into for a 5-inch aspbalt concrete at the rate of 11¾ cents per square foot including grading; also tbat in Fresno, contracts for a similar 5-inch pavement were entered into at the rate of 13 cents per square foot including grading; also that in Madera, similar contracts were made at tbe rate of 14 cents per square foot including grading.

RECOMMENDATIONS.

In conclusion, we would remind your body that approximately 70 per cent of the burden of taxation will fall upon the incorporated cities. If poor pavements, or experimental pavements are laid between cities, they will be tbe greatest sufferers and would therefore have the best right to be heard in tbe matter of pavements. In view of tbe seriousness of adopting improper specifications we would recommend tbat you give the matter your careful and immediate attention.

Respectfully submitted.

(Signed) CHRIS P. JENSEN.
S. J. VAN ORNUM.
J. J. JESSUP.

Anti-Road Sign Movement

Judging from the general tenor of newspaper comment, public sentiment throughout the State is warmly in sympathy with the movement started by the Civic Section of the California Federation of Women's Clubs of the Northern District for the protection of the state highway system against the hideous road sign which obliterates the landscape and mars the beauty of the scenery along nearly all of California's highways.

Mrs. Bradford Woodbridge, of Roseville, chairman of the Civic Section and Mrs. George W. McCoy, of Placerville, president of the Northern District of the Federation, are leading in this aggressive campaign.

It is needless to say that the California Highway Commission endorses the movement which these public-spirited ladies represent.

The State Printing Office

The renovated, reorganized State Printing Office, under State Printer F. W. Richardson, is another department of the administration which is conducting a great public work along thorough business methods. This Bulletin is a testimonial in this respect that speaks for itself. The Highway Commission uses large quantities of printed matter—and the State Printing Office is doing the work in a high-class manner at bed-rock commercial costs.

Warning Signs for Torn-Up Roads

It is obvious that during the construction of state highways, public travel must be inconvenienced to a considerable extent. To minimize the annoyance, the following General Instructions have been issued:

GENERAL INSTRUCTIONS TO DIVISION ENGINEERS No. 76.

To Division Engineers of the California Highway Commission.

GENTLEMEN: In the future and until further orders you will, acting under section 4 of the specifications, instruct the contractors in all cases of light grading that the road is not to be torn up for more than one half mile in advance of the completed pavement.

In the case of oil concrete the half mile may be measured from the completed concrete notwithstanding that the concrete has not sufficiently hardened to receive the traffic.

Nothing in this letter should be construed as prohibiting the building of culverts if proper by-passes are maintained, the working outside of the traveled way, or the rough grading of heavy work where time for settlement is necessary before the pavement can be laid thereon, even though these operations be more than one half mile in advance of the completed pavement.

Yours very truly,

(Signed) A. B. FLETCHER,
Highway Engineer.

GENERAL INSTRUCTIONS TO DIVISION ENGINEERS No. 84.

To Division Engineers of the California Highway Commission.

GENTLEMEN: You will see that the following order relative to "ROAD CLOSED" signs is observed on all state highway constructions in your division.

Road Closed Signs.

Before construction begins on any state highway, warning signs shall be erected, at the expense of the State, under the direction of the Resident Engineer, in the manner following:

(*a*) Three types of sign will be furnished by Headquarters, printed on cloth, reading as follows:

(Type 1)

STATE OF CALIFORNIA.
DEPARTMENT OF ENGINEERING.
CALIFORNIA HIGHWAY COMMISSION.
STATE HIGHWAY UNDER CONSTRUCTION.
POSITIVELY NO PASSING.

(Type 2)

STATE OF CALIFORNIA.
DEPARTMENT OF ENGINEERING.
CALIFORNIA HIGHWAY COMMISSION.
STATE HIGHWAY UNDER CONSTRUCTION.
ROAD DANGEROUS BUT PASSABLE.

(Type 3)

STATE OF CALIFORNIA.
DEPARTMENT OF ENGINEERING.
CALIFORNIA HIGHWAY COMMISSION.
STATE HIGHWAY UNDER CONSTRUCTION.
----------MILE-- BEYOND THIS SIGN.
TURN HERE.

(*b*) The cloth signs will measure 25 inches by 38 inches and they are to be attached to substantial sign boards with moldings to prevent the fraying of the edges of the cloth. The boards shall be securely fastened to 3 inch by 3 inch scantling, the bottom of the sign to he 4 feet above the ground and the posts to be set 2½ feet into the ground.

(*c*) The signs shall be placed:

1. At the beginning and at the end of each portion of the road torn up.
2. At every road entering or intersecting the road torn up.
3. At road forks sufficiently distant from the road torn up to give travelers ample warning that the state highway is under construction, and not passable. The resident engineers shall fill in the "distance blank" on such signs.

(*d*) All such signs shall be properly lighted at night by lanterns furnished by the Contractor.

(*e*) The sign boards shall he removed as soon as conditions will permit and taken care of so that they may be again used elsewhere.

Yours very truly,

(Signed) A. B. FLETCHER,
Highway Engineer.

Building the Highway Through Cities

The question of jurisdiction and responsibility over those links of the state highway which might lie within the limits of incorporated cities and towns, at the outset occasioned some perplexity. But the Commission promptly met the situation by determining to adopt the fixed policy of leaving to the towns and cities which the highway might touch the building and maintenance of these connecting links.

This seemed the only logical course to pursue. The use by the city of its own streets is manifestly always far in excess of any possible through or outside travel. Not only the first cost of construction but the expense of maintaining a city's streets are legitimate charges against the municipality. No town wishes to surrender the control of any of its thoroughfares to the State. The right to have a free hand in the granting or denying of franchises for street car lines, the laying of water and gas mains and the erection of telegraph and telephone poles along its public streets is the jealously guarded prerogative of every municipality.

"Old Shasta" is on the State Highway.

But while the Commission has decided to build the highway only to and from the limits of incorporated cities, due attention has been given to negotiations with all cities and towns that may possibly be touched by the highway, to the end that such municipalities shall pledge themselves to construct the connecting link of the state highway within their limits in as good form and manner as that of the state highway to and from such town.

It is significant that not a single city or town has demurred to this proposition. In many instances, the coming of the state highway, knocking at the doors of a lethargic community, has aroused it to undertake not only the permanent improvement of the "link," but to inaugurate a general campaign of street building and civic progress.

CALIFORNIA STATE LIBRARY
FOR FREE INFORMATION ABOUT CALIFORNIA
FERRY BUILDING
SAN FRANCISCO

Chart of Organization

The accompanying chart is an analysis of the organization of the California Highway Commission. The diagram illustrates the Commission's relationships to the Department of Engineering, the Administration and the State, and traces its own internal ramifications.

This chart was worked out by the firm of Klink, Bean & Co., expert accountants, who also devised and organized the Commission's accounting system.

In subsequent numbers the Bulletin will more fully explain this most important department.

The Power of the Press

Through a press clipping bureau service, this Commission is fairly well posted as to highway movements and agitations throughout the State; but a prompter and more satisfactory gleaning of news and comment is obtained directly from the columns of those newspapers which are mailed regularly to the Commission. Publishers of the following journals courteously accord such favor to this department:

Daly City Record.	Oxnard Courier.
Placerville Republican.	Stockton Record.
Sacramento Tribune.	Delano Record.
Yolo Independent.	Dinuba Sentinel.
Ukiah Press Republican.	San Mateo Times.
Grizzly Bear.	Downicville Messenger.
Wheatland Four Corners.	Biggs Argus.
Glendora Gleaner.	

Hardly ten counties, however, are represented hy these publications.

It might be well worth while if the various boards of supervisors caused one or more of their representative local newspapers to be mailed to the Highway Commission regularly, in order that the activities of all these counties in public road improvement may be the more fully and promptly reported to this department.

The newspapers of California, almost without exception, are constant and effective champions of the good roads cause.

This Bulletin could profitably devote a page in each number to a résumé of the editorial expressions and news reports with reference to good roads that from month to month may be gleaned from these local papers.

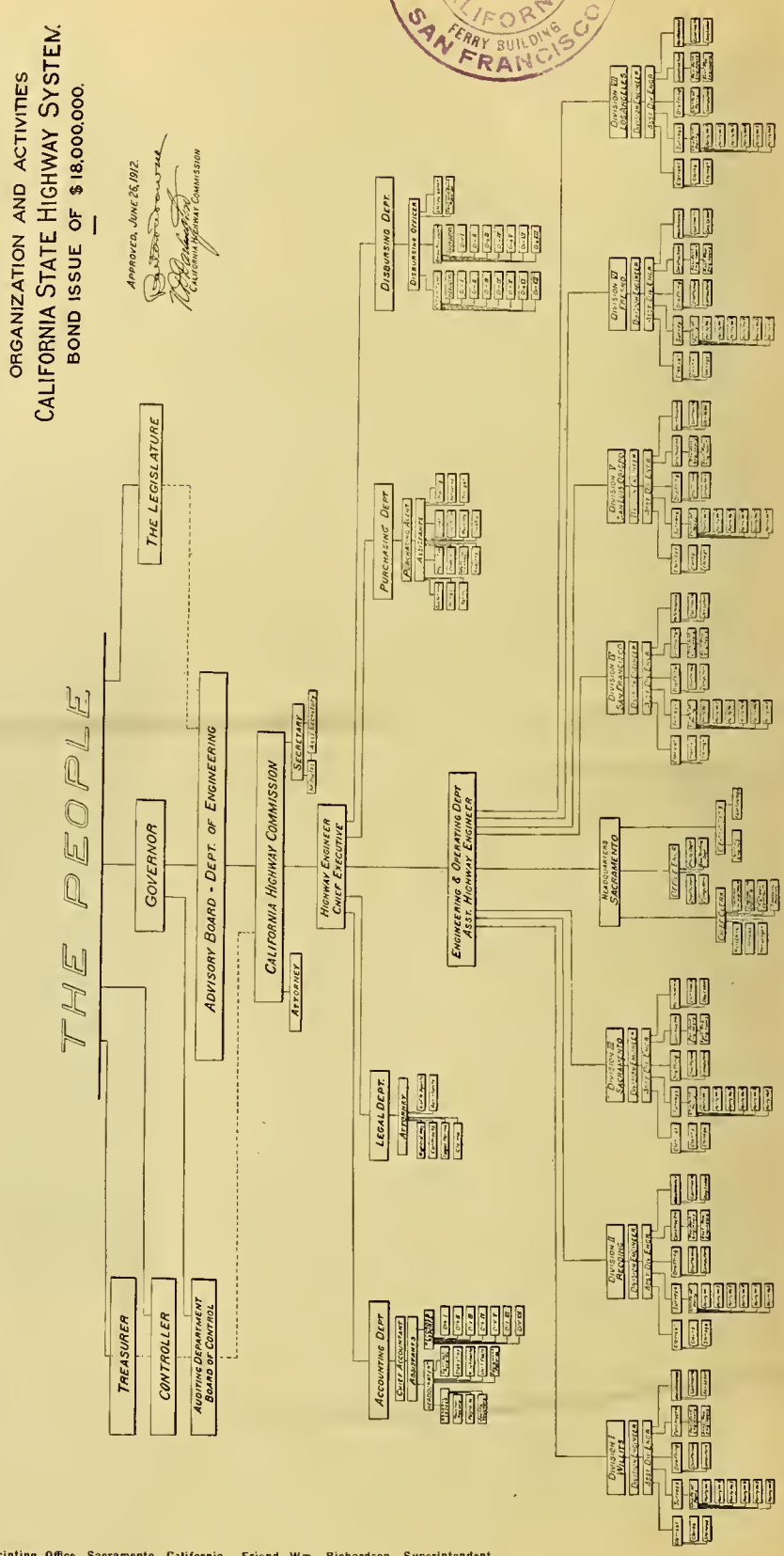
The Secretary's office regularly clips and classifies all such press matter for the perusal of the Highway Engineer and the Commissioners.

The Maintenance Problem

The California Highway Commission at its regular session on September 23d formally instructed the Secretary to address a letter to Hon. A. B. Nye, State Controller, informing him that in the opinion of this Commission the sum of $200,000 should be appropriated by the ensuing legislature for the purpose of maintenance of the state highway during the years 1913 and 1914.

This maintenance problem must be met and solved by the State, and the Commission believes that in thus calling the State Controller's attention to the matter a timely step has been taken which insures that the next Legislature will give the subject its careful consideration.

The second number of the California Highway Bulletin will appear December 15, 1912. Its preparation has already begun.

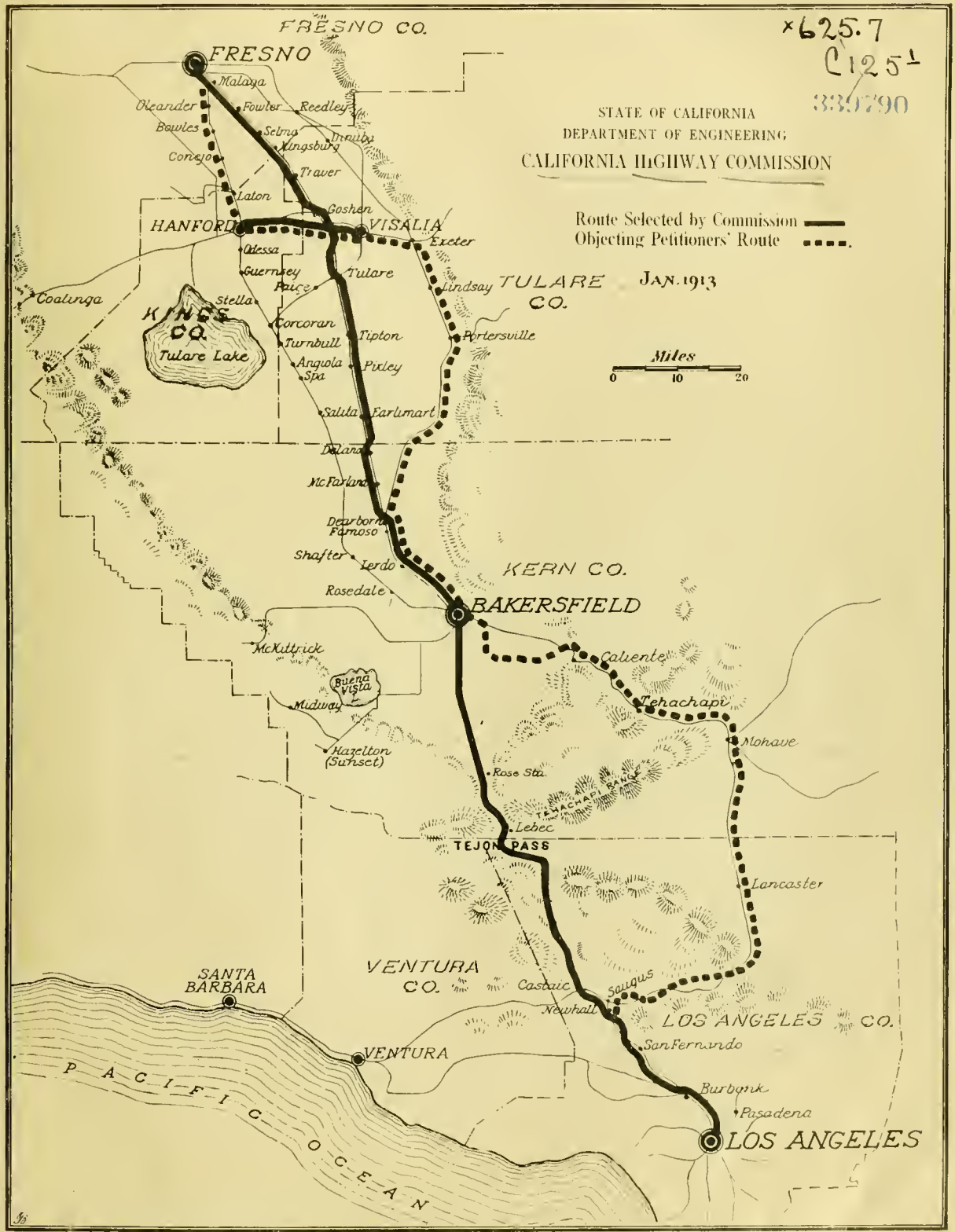


Printed at the State Printing Office, Sacramento, California. Friend Wm. Richardson, Superintendent.

CALIFORNIA HIGHWAY BULLETIN

VOLUME I SACRAMENTO, CALIFORNIA, MAY 1, 1913 NUMBER 2

×625.7
C125¹
339790



Printed at the State Printing Office, FRIEND WM. RICHARDSON, Superintendent

CALIFORNIA HIGHWAY BULLETIN

PUBLISHED BY THE

CALIFORNIA HIGHWAY COMMISSION

OF THE

Department of Engineering

State of California

BURTON A. TOWNE, CHAS. D. BLANEY, N. D. DARLINGTON
Commissioners

AUSTIN B. FLETCHER, Highway Engineer
GEORGE R. WINSLOW, Assistant Highway Engineer
CHAS. C. CARLETON, Attorney
W. R. ELLIS, Secretary

Forum Building, Sacramento, California

DIVISION ENGINEERS—OFFICE ADDRESSES:

Division I. F. G. SOMNER, ... Willits, Mercantile Building
Division II. T. A. BEDFORD, ... Redding, C. R. Briggs Building
Division III. W. S. CARUTHERS, ... Sacramento, Forum Building
Division IV. A. E. LODER, ... San Francisco, Rialto Building
Division V. W. C. HOWE, ... San Luis Obispo, Union National Bank Building
Division VI. J. B. WOODSON, ... Fresno, Rowell Building
Division VII. W. L. CLARK, ... Los Angeles, Union Oil Building

TABLE OF CONTENTS.

	Page.
Amend the Postal Laws	2
Selling the Highway Bonds	2
The State Highway and the Cities	2
State vs. Local Highways	3
Reconnaissances Ordered	3
California State Highway Policy	3
Financial Statement	3
Administering the State Highway Trust	4–6
Progressive San Mateo County	6
Controversies Over Highway Routes Reviewed	7–11
Governor Hears the Complaining Contractors	11–12
State Highway Construction Severely Tested	14
Work of the Commission's Testing Laboratory (by C. B. Osborne)	14–15
Across the Yolo Basin	15
Detailed Progress Report of the State Highway Work	16–18
How Big is California?	18
Complete Table of California State Highway Layouts	19
Typical Sections of State Highway	19
The Maintenance Problem (by Benjamin Ide Wheeler)	20
The Counties Will Build Them	20
Madera's State Highway	20
Progressive California Counties	20
A Beautiful Boulevard	20
Sausalito Shows the Way	20
Fiscal Agency Too Long Delayed	20
Story of the Rebuilding of Historic El Camino Real (by A. E. Loder)	21–22
Glenn County Stony Creek Bridge	22
Securing Rights of Way for the State Roads (by Chas. C. Carleton)	23
Roller Skating on the State Highway	23
Plotting the Plans and Profiles—Layouts	24
San Joaquin County's Traffic Census Report	24

AMEND THE POSTAL LAWS

As stated in the initial issue of this Bulletin, the Commission planned to publish it bi-monthly. Failing, however, to obtain the permission of the Postal Department to enter the publication as second-class matter, and on account also of the slow sale of the highway bonds, it was deemed expedient to defer the issuing of this number.

The Bulletin, as a medium for conveying to the public reports of the progress of the Commission's work and of interchanging information of an educational character along all road building lines between state and county authorities, is a valuable publication.

The Commission hopes to continue it at regular, stated intervals. To this end, it is urged that our representatives in Congress take up the matter of amending the laws governing second-class mail matter so that publications of the character of the CALIFORNIA HIGHWAY BULLETIN shall have equal privileges with the publications of State Horticultural, Educational and Health Boards in enjoying second-class postal rates.

The Government has a direct business interest in promoting the good roads movement and it is consistently giving moral and financial aid to this cause for the reason that every mile of good roads facilitates and reduces the cost of the Government's rural mail delivery service.

It is hoped that the highway departments of other states will co-operate with the California Highway Commission in urging upon Congress the merit of this contention.

THE AGITATION TO SAVE the native timber along the state highway, particularly through the native groves of pine and redwood in Mendocino, Humboldt, and Del Norte districts, should be reinforced by the press and civic bodies of the State. Let the state highway be a natural parkway from Oregon to the Mexican line.

SELLING THE HIGHWAY BONDS

On the 17th of April, the State Treasurer, Hon. E. D. Roberts, sold $800,000 of the state highway bonds, the full allotment last ordered sold by the Advisory Board of the Department of Engineering.

Subscribers to these bonds were various local banking houses, as follows:

Orange County banks	$200,000
Santa Clara County banks	148,000
Santa Cruz County banks	75,000
Mendocino County banks	30,000
Los Angeles County banks	270,000
Board of Control	77,000
Total	$800,000

Immediately following this sale, the local banks of Salinas offered to take $50,000 worth of the bonds and Hollister banks $25,000. The Salinas and Hollister subscriptions were made on condition that the full amount of $75,000 would be applied to the construction of the state highway via the San Juan route.

Including this sale, the total sales of the state highway bonds is exactly $4,000,000.

The following purchases of state highway bonds have been made by the various banks throughout the State with the understanding that the proceeds would be expended in the construction of the state highway in the respective districts where the money was subscribed:

Hibernia Savings and Loan Society, San Francisco	$200,000
Bank of Willits	16,000
Security Trust and Savings Bank, Los Angeles	250,000
First National Bank, Los Angeles	150,000
Bank of Italy, San Francisco	50,000
German Savings and Loan Society, San Francisco	50,000
Associated Banks of Sacramento and A. Mierson Bank	25,000
San Bernardino National Bank	175,000
Citizens National Bank of Riverside	100,000
Associated Banks of Humboldt County	100,000
Hibernia Savings and Loan Society, San Francisco	100,000
Associated Banks of Sacramento and A. Mierson Bank	125,000
Union Savings Bank, Modesto	75,000
Sale of April 17th as above noted	800,000
Total	$2,139,000

In Contra Costa, Alameda, Tuolumne, Santa Barbara, Sonoma, Ventura, Sacramento and other counties, public spirited efforts are in progress to induce local capitalists to take state highway bonds in sufficient quantities to provide the money necessary to build the state highway through their several jurisdictions.

The logic of these facts can not be misunderstood. The Commission will inevitably be compelled to give preference to those counties which are thus promptly co-operating with the State Treasurer in marketing the highway bonds, if the bonds do not find independent purchasers.

THE STATE HIGHWAY AND THE CITIES

The streets of an incorporated town are not under state control. No self-respecting city desires to surrender its authority over any portion of its own thoroughfares. For these basic reasons, the Highway Commission is pursuing the settled policy of requiring the various towns through which the state highway is routed to build the "link" of the big road through its confines.

It is the custom of the Commission to confer with the authorities of such towns, and as far as practicable follow their recommendations in locating the main road to and from these towns.

Conforming to this rule, the city of Roseville, Placer County, on April 15th, voted almost without opposition for a bond issue of $20,000 for the permanent improvement of the street which will be used by the state highway.

Los Gatos, Santa Clara County, will build its connecting link at a cost of $60,000. It will have a concrete base and will be surfaced with asphalt.

Pomona, Los Angeles County, plans to build at once her state highway "link" at a cost of $50,000.

Gilroy proposes to spend $34,000 on her "connecting link" of the state highway and to lose no time getting at the work.

No other movement ever started so much civic activity and ambition among the counties as well as the municipalities of California, as has this state highway enterprise.

THE SUPERVISORS OF VENTURA COUNTY have about completed a long concrete bridge of the Thomas type on the state highway between Ventura and the Rincon Causeway at a cost of about $50,000. The bankers of Santa Barbara County are arranging to purchase highway bonds to enable the Commission to commence the construction of the state highway between these two bridges.

STATE vs. LOCAL HIGHWAYS

It was inevitable from the beginning that every county, city, town and hamlet in the State should petition for the state highway through their borders in a manner that would best serve their own local interests.

In law and in logic, in morals and economics, there was but one course for the Commission to take—that was the course it adopted. It proceeded to determine the location of the trunk lines of the State, obliterating county lines and disregarding the special pleas for special consideration from a multitudinous and contesting lot of communities.

By the closest calculations the Commission estimated that it would require about 1,800 miles of trunk lines and 900 miles of laterals to complete the skeleton system of state highways as defined by the highways act. If the state highway were really to be a STATE HIGHWAY, the Commission at the outset conceived that it must necessarily perform substantially the functions of a great artery, and that in the language of the act it should follow the most "direct and practicable" route.

Wherever any serious protest has been made against the action of the Commission, in determining these routes, it has arisen from those who put their pleas and protests solely upon the ground of their local interests, and who plainly sought to divert the state highway through their particular towns and sections for the purpose of best serving the local traffic.

The ambition of the California Highway Commission has been to see the two trunk lines of the state highway routed, as the law contemplates, so that they will most efficiently serve their purpose as *trunk lines*, to which the various counties may tie their county highway systems. Several counties in the State have already bonded themselves into the millions and have constructed from one hundred to three hundred miles of permanent roads within their borders. There are perhaps a dozen more counties now energetically moving in the same direction.

Having knowledge of these facts, the California Highway Commission, from the beginning, relied upon the various counties to take up the problem of their local highway needs and build by county enterprise all these roads which have been urged upon but which have not been accepted by the Commission.

No state highway can perform the promiscuous functions of a county highway system.

Take for instance the little state of New Jersey. It has an area of 8,224 square miles as against California's 158,297 square miles. Our Kern County alone has several hundred miles more dry land area. Yet New Jersey with but little more than five per cent of California's area, according to the 1911 report of the Commissioner of Public Roads of that state up to November 1, 1911, had given state aid under the state aid law to twenty-one counties in the aggregate sum of $3,230,336, which applied on a total of about 1,600 miles of public roads. A map accompanying this report shows by a network of red lines the vast system of public roads that has thus partially benefited under New Jersey's state aid law.

Reference is here made to these figures from New Jersey for the purpose of giving the reader an idea of the great mileage, in the aggregate, necessarily required to serve the local highway traffic demands, and it further will convey to any one who has not given the matter much thought some concepton of the difficulties and complications, entanglements and irreconcilable conflicts that would inevitably arise if the attempt were made to make a state trunk road answer the purposes of a variety of county highway systems.

RECONNAISSANCES ORDERED

In the matter of the Tuolumne County lateral, upon the recommendation of the Highway Engineer, it was ordered recently that the reconnaissance should follow a line beginning on the state highway at Farmington, San Joaquin County, thence southeasterly to Knights Ferry, thence northeasterly via Chinese Camp to Sonora.

As soon as this proposed road has reached the layout stage, the citizens of Tuolumne will buy bonds sufficient to insure its construction.

March 4th last, the Highway Engineer was authorized to proceed with a reconnaissance to be made, preparatory to a survey, of a possible route in Contra Costa County, beginning at Martinez and extending substantially parallel to the coast line and upon the high lands back of the water front to a point near Port Costa; thence via Richmond to Oakland, together with branch lines to Port Costa and to Vallejo Junction.

THE FIRST AND MOST EFFECTIVE argument that any county can offer why the Commission should begin the construction of the state highway in its particular district is to show that it has procured all rights of way in accordance with the State's survey.

CALIFORNIA STATE HIGHWAY POLICY

In bonding itself for $18,000,000 for a state highway system without restrictions as to the time in which the money should be expended, California adopted a bold and unique program. Other states had theretofore voted even larger sums for public road improvement, but with the proviso that the money should be disbursed in installments over a long term.

California's venture in state highway building is distinguished by still another radical departure from the methods of other states in that the highways act itself, which the people adopted when they voted the $18,000,000 bonds, practically determines within narrow lines the location of the two main trunk roads for which it provided.

In other states, after the bonds were voted, the matter of locating the state roads has usually been left to some commission or advisory board.

Many of the eastern states have adopted the state aid method of encouraging the various counties to improve the public highways. A bonus, varying from $250 to $1,250 per mile, according to the character of road, is paid by the state upon proper proofs. By this system those counties that are most enterprising get the most road "benefits." There is no mandatory road construction, and in practice, desultory and scattered work is the result.

The California plan, whereby the State makes available its funds as rapidly as they may be utilized, and plans the work as a magnificent whole and to be prosecuted as one great enterprise, commends itself as the wisest and most progressive.

The Bulletin, in its October issue, published the full text of Attorney General U. S. Webb's opinion as to the meaning of the State Highways Act. Any one who has read the act itself with any degree of attention could not have been surprised at the Attorney General's findings. The framers of that act clearly contemplated that the State should proceed to construct two main or trunk roads throughout the length of the State, one along the coast and one up and down the two great valleys, Sacramento and San Joaquin. The act specifically declares that these trunk lines shall be laid out by the "most direct and practicable routes," and that the county seats of such counties as may lie east or west of the said trunk lines shall be connected by laterals.

The law very explicitly limits the discretion of the Commission in the matter of locating these highways but gives it unchecked freedom in the manner of spending the money and the time in which it may accomplish the work. In routing the state highways, the California Highway Commission has studiously undertaken to comply with the provisions of the State Highways Act.

FINANCIAL STATEMENT

The following is a statement to March 15, 1913, showing gross receipts and disbursements of the Commission and a segregation of the expenditures among the seven divisions:

ASSETS.

Total expended for surveys and construction of highways	$859,433 42
Overhead expense to be prorated	63,770 07
Investment in equipment	68,636 20
Revolving fund	400 00
Balance in bank	1,389 23
	$1,003,628 92

LIABILITIES.

State Highway Fund	$948,385 85
Reserve on uncompleted contracts	53,553 84
Claims in process of payment	1,689 23
	$1,003,628 92

Details of expenditure	$869,433 42	
Division I		$125,789 23
Del Norte, Humboldt, Mendocino.		
Division II		42,765 02
Lassen, Modoc, Shasta, Siskiyou, Tehama.		
Division III		175,697 31
Butte, Colusa, El Dorado, Glenn, Placer, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, Yolo, Yuba.		
Division IV		155,766 30
Alameda, Contra Costa, Marin, Napa, Santa Clara, Santa Cruz, San Mateo, Sonoma.		
Division V		65,823 49
Monterey, San Benito, Santa Barbara, San Luis Obispo.		
Division VI		160,070 79
Fresno, Kern, Kings, Madera, Mariposa, Merced, Mono, Tulare.		
Division VII		143,531 28
Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura.		
	$869,433 42	
Bonds sold to date		$3,200,000 00

ADMINISTERING THE STATE HIGHWAY TRUST

How the California Highway Commission Determines the Routes, Organizes Its Field and Office Forces, and Manages the State's Business

The State Highways Act, in language that a layman cannot misunderstand, makes it mandatory to build one main interior trunk line running lengthwise of the State, and another trunk line along or near the coast, and to connect them by laterals with all county seats not touched by one or the other of these trunk roads.

Thus was the state highway system definitely determined by direct vote of the people and made obligatory beyond the power of any court or legislative body to change.

It is a highway system which compels the building of about 1,800 miles of trunk roads and about 900 miles of laterals.

From the very beginning, it was apparent that the eighteen millions provided by the State Highways Act was woefully inadequate to satisfy the demands of the people.

Recently certain large road building contractors went into the public knowledge or respect for the law that must control those who are officially responsible, crying that the Commission ought to be spending $12,000 a mile instead of $7,600 a mile to construct these highways.

At $12,000 per mile, $18,000,000 will build 1,500 miles of roads.

But to put various ambitious towns on the state highway and to "keep peace in the family," the trunk lines must be stretched by a series of kinks and zigzags to a total aggregation of 2,150 miles of kinks and zigzags.

But there is money only to build 1,500 miles of road of the kind the contractors want. Therefore, there would be on this basis 650 miles of trunk lines and 900 miles of laterals, more than one half of the entire mileage of the state highway system, to build which there would remain not one dollar of the $18,000,000.

The most casual and unconcerned onlooker will readily discover that

Pit River Bridge Site, Shasta County. State Highway Survey.

prints with a protest addressed to the Governor, charging that the Highway Commission was building the roads in an inferior manner.

At the hearing which the Governor gave these criticising contractors, they told his Excellency that it would cost approximately $12,000 a mile to build the type of road which they recommended.

At $10,000 per mile, 1,800 miles of main highways would cost every copper cent of the eighteen million dollars and leave not a penny for the construction of 900 miles of laterals.

Here, then, is the situation. The California Highway Commission on the one hand is railed at and abused, as if they were picking pockets, because they have not ordered surveys for the state highway by various diversions to satisfy conflicting and irreconcilable local demands, increasing the eighteen hundred miles of trunk roads to over twenty-one hundred miles, and adding upwards of $3,000,000 to the total cost of building these said trunk roads alone.

On the other hand, the contractors rush in blindly, without apparent this Commission at the outset faced an engineering and financial problem all but impossible of solution even with the greatest conceivable skill, economy, and administrative ability.

But when upon top of the inherent and unescapable difficulties which beset the Commissioners are piled the burden of satisfying the clamorous petitioners of hundreds of towns to have the highway run in as many impossible directions, and to build a kind of road that best suits the notions and purposes of those who are stocked up with large road building plants of a certain sort, it is taxing human patience to the limit.

The Policy of the Commission.

The management of this state highway enterprise concerns primarily the public which foots the bills.

In order to make the $18,000,000 cover the cost of the best possible state highway system, the following policy was programmed at the outset by the Commission:

1. To prevail upon all counties to pledge themselves to procure all rights of way and construct all necessary bridges for the state highway in their various jurisdictions.

2. To lay out the entire system of trunk roads and laterals in accordance with the mandates of common sense, the State Highways Act and the opinion of the Attorney General by "the most direct and practicable routes."

3. To organize every department under the Commission on a merit and efficiency basis, in line with the promise and the efforts of the administration to apply clean, practical, business methods to the management of public affairs.

State Highway Surveyors Moving Camp, Rattlesnake Creek, Mendocino County.

4. To declare that the State will step into the breach and defend any contractor in the courts, without cost to him, against any suits for damages or royalties for the invasion of real or alleged rights under paving patents.

5. To make definite arrangements with the various railroad companies for a special reduced freight schedule for all road building materials, equipment, etc., transported for the construction of the state highway.

6. To enter into contract with the lowest bidders for a vast wholesale supply of crushed rock, gravel, etc., by the definite terms of which these materials should be supplied to the State far below the price usually paid by contractors on other public or private works.

7. To propose to the cement companies to place large orders for cement to be delivered and paid for within a stated period, and demanding their closest estimates in consideration of such guarantees of large orders, positively placed and promptly paid for.

8. To let contracts for construction of the state highway in ten mile units, and give all contractors the benefit of the reductions in freight rates, and first cost of rock, gravel and cement under the aforesaid arrangements with transportation companies and material men, thus affording the small contractor as far as possible an equal chance with the large contracting concerns.

9. To maintain a testing laboratory, and scientifically examine and prove according to established standards all rock, sand, gravel, cement, asphalts, oils, etc., that may be used in state highway construction.

The public deserves to know just how consistently and just how successfully the Commission thus far has adhered to its program as above outlined. Not to solicit plaudits nor encomiums, but simply to inform the public as to the real situation, it is pertinent and proper to state the following facts.

How the Counties Have Co-operated.

Not a single county in California has rejected the overtures of this Commission to furnish all rights of way and construct all necessary bridges in their several jurisdictions without cost to the State. These savings of time and money to the State by this generous and prompt co-operation from the various counties are enormous and incalculable.

In nearly every county through which a trunk line or any lateral of the state highway has been considered, the Commission has been appealed to to act as umpire in settling the contentions of rival communities which sought to have the state highway routed by various diversions.

With only a few exceptions, every county in the State has acquiesced in and agreed to the proposition maintained by the Commission that the state highway is in fact as well as in name A State Highway.

They readily saw the point that it was absolutely necessary for each town, city and county to hold its own local desires and interests as to the location of the state highway subordinate to the larger and all inclusive purposes of the state highway system.

It was agreed that a trunk line of a state highway could not be diverted and distorted merely to meet the requirements of local traffic without abandoning and violating the letter and spirit of the Highways Act as well as the basic needs of the highway system itself.

These various counties through their supervisors, chambers of commerce and boards of trade in effect said to the Commission, as the only solution of their own internal and irreconcilable differences as to where the state highway should go: "Locate the state highway through this county where the Highway Commission thinks best to serve the purposes of a trunk road to which all the counties may tie their local highway systems."

Upon this principle only is it possible to link all sections of the State together in a system of good roads that will afford the freest intercommunication between each section with every other section.

Thus it was that the counties which had not only generously assumed the expense of furnishing rights of way and building bridges still further contributed magnanimously to the success of the state highway enterprise by declaring for the most "direct and practicable" routing, to the end that the total mileage and the consequent cost of construction might be reduced to the minimum, to the still further end that these roads should be constructed in as high class a manner as possible, and should be extended in fairness and equity to reach all sections of the State as contemplated by the State Highways Act.

Confirming this position, several counties have recently voted bonds for the permanent improvement of their local highways; and many other counties are actively preparing to do likewise.

Riverside and Orange counties; Kern and Santa Barbara; Fresno and Tulare; Santa Cruz and Monterey; Solano, Contra Costa and Alameda; Sonoma, Mendocino and Humboldt; Butte, Shasta and Siskiyou; San Mateo, Merced, Tuolumne and Imperial are all public-spiritedly grappling with the good roads problem, and planning to join their local road systems to the State's trunk highways.

Honor is due to Los Angeles, San Diego and San Joaquin counties as pioneers in county road improvement. These three counties alone are bonded in the aggregate for six and one half million dollars for the betterment of their roads, a sum considerably in excess of one third the entire amount available under the State Highways Act, for the construction of the entire state highway system.

This fact alone is sufficient to indicate to the most obtuse mind that it is little short of a crime to route the state highway by a deviation of a single mile to satisfy purely a local interest. To follow such a practice would inevitably deny in toto the benefits of the state highway fund to entire communities and counties.

Organization of Field and Office Forces.

Concerning the organization of the office and field forces of the Commission, it is sufficient in passing to say that the fact that the employees of the Commission have uniformly been employed upon recommendations as to their efficiency, skill and experience, and that the uniform rule of the Commission to promote and discharge employees without discrimination, solely upon their merits, has occasioned general surprise and favorable comment throughout the State.

It is simply asserting what is common knowledge to say that in no administration of the government of the State of California prior to the present one would it have been possible to have undertaken and prosecuted any great public work, such as this state highway enterprise, under these conditions.

However, the Commission fully recognizes that efficiency in the public service cannot be divorced from the spirit of loyalty to the principles of good government. Working harmony in the ranks, and a zeal for earnest, faithful service, is best promoted in any organization by uniformly requiring that every employee shall stand the test of fidelity as well as efficiency.

Fidelity is an indissoluble element of efficiency in practical affairs as well as consistency in morals.

As to Paving Patents and Injunction Suits.

In the first issue of the CALIFORNIA HIGHWAY BULLETIN, which appeared last October, the Commission announced its policy of standing in between the small contractor and the powerful paving concerns assuming to do business under the protection of certain patents, and declared its purpose to defend any and all suits that might be launched in the courts to enforce the payment of any damages or royalties that might be claimed as infringements of such patents. The Commission did not undertake to deny the validity of any of these patents, but simply asserted that, if there were any valid claims for royalties, etc., the State would be responsible.

In this connection, the Commission stated: "Often a suspicion exists that both the contractors and the persons claiming patents are increasing their incomes unduly at the cost of the people." The threat of starting an injunction suit for the collection of damages or royalties often operates either to scare the contractor out of bidding, or cause him to enter into collusion with other contractors to control the situation. Thus far the Commission has not been called upon to defend any such suit.

Reduced Freight Rates Obtained.

Under the terms of a special tariff schedule the various railroad companies of California have united in conceding to the California Highway Commission carload rates for the transportation of all kinds of road building materials, machinery and equipment for road construction, which amounts to a saving of several hundred thousand dollars. It is worthy of note that various contractors, who are building bridges for the counties to be used by the state highway, are also given these reduced rates, which often amount to a saving of 50 cents per ton.

Road Materials at Bedrock.

In November of the past year, the Commission entered into a contract with one of the largest crushed rock producers in the world for a supply of one half million tons of crushed rock to be delivered at the option of the Commission within a stated period at the rate of 45 cents per ton.

The Commission further has entered into contracts with various companies supplying gravel, to deliver the same at the option and at the order of the Commission for the construction of the state highway at the rate of 27½ cents per ton. That these prices are bedrock and hard to beat is evident. With all the rivalry of competing firms, the Commission is unable to find any of them prepared to supply these materials at a less price.

While the cement companies maintain their prices rather rigidly, the Commission is buying its cement at comparatively low figures, considerably below the current market prices.

Testing All Materials Used.

Furthermore, the Commission maintains a laboratory for the testing of all materials that enter into the construction of the state highway. All cement, sand, rock, gravel, asphalts and oils are examined by this department of the Commission and scientifically tested for the purpose of insuring that all materials shall be up to the standard of quality demanded by the specifications of the Commission.

Giving the Smaller Contractors a Fair Chance.

In order that there shall be a free and open field in the bidding for all contracts to build portions of the state highway, it is the policy of the Commission, first, to let these contracts in units of about ten miles. A contractor of moderate means can usually handle a job of this size. By giving the contractor the benefit of the relief of furnishing materials and their delivery by the transportation companies, the capital required by a contractor to handle a contract is greatly reduced and he is thereby placed in a more independent position. Furthermore, he is relieved of the temptation to hold out materials, or use inferior substitutes, for the reason that the State furnishes these materials and there is no opportunity for him to dishonestly increase his profits.

Engineer Morton's Significant Testimony.

It is significant that Mr. R. M. Morton, Highway Engineer of the San Joaquin County Highway Commission, which is just completing the expenditure of upwards of two million dollars in the construction of its system of county highways, should testify that so far as his reading, his knowledge, and his experience enable him to judge, the California Highway Commission is breaking all records made by the counties or by other states in reducing the cost of road building. Mr. Morton frankly says that, considering the type of roads the Commission is building and the high class manner in which they are constructed, it is surprising that the cost is held down to the figures at which the work is done.

An Encouraging Outlook.

With an increasing number of counties preparing to co-operate with the State Treasurer in the matter of floating the state highway bonds, under assurances that all the money available from the sale of these bonds through the efforts of the counties will be applied exclusively to the construction of the state highway in these counties, and with the brightening prospect that disputed routings will, at an early date, be definitely and finally determined, it may be safely predicted that before the end of the year 1913 splendid progress will have been made, not only by this Commission but by all our enterprising counties from Siskiyou to San Diego in the permanent improvement of our public highways and toward the consummation of the dominant ambition of every community of California to be ready and on dress parade for 1915.

Progressive San Mateo County

On the 8th of April, by a vote of "Yes," 4,253, and "No," 1,044, over 4 to 1, the people of San Mateo County declared for a bond issue of $1,250,000 for the permanent improvement of about 110 miles of roads.

Grading State Highway Near Hopland, Mendocino County.

The proposed county system has been laid out carefully by an executive committee of the board of supervisors in consultation with experts to connect all sections of the county to the best possible advantage with the trunk line of the state highway.

No time is to be lost in carrying into execution this program. Consequently San Mateo County is looking forward to an era of unprecedented development and prosperity.

CERTAIN PUBLIC SPIRITED CITIZENS in Santa Barbara County have recently guaranteed the purchase of a large block of highway bonds to provide for the early construction of the state highway between Elwood and Gaviota Pass. This is encouraging since it will be the first voluntary money available for state highway construction on the coast road.

CONTROVERSIES OVER HIGHWAY ROUTES REVIEWED

A Comparative Study of the San Juan vs. Watsonville, the Tulare City vs. Hanford-Visalia, the Tejon vs. Tehachapi, and the Zaca Canyon vs. Alisal Routes

For many months the members of the California Highway Commission and the Highway Engineer have personally traveled and inspected all the routes which are the subjects of discussion in the protests, have in repeated hearings listened to the arguments of the proponents and opponents of the routes involved, have carefully examined written evidence of every description, and each and every recommendation for a particular route has been made to the Advisory Board only after a thorough investigation by the Commission's engineers.

The three members of the Commission, therefore, have investigated the merits and demerits of the routes, which have been advocated in the various sections of the State, as much as any body of men could do within a reasonable length of time, so that construction work might proceed to afford the people of the State some improved highways by the important year of 1915 Their investigation has been thorough in every respect.

In arriving at its determination of routes the Commission has been influenced by the following considerations:

Fourteen Dominant Reasons.

First—That the "State Highways Act" contemplates the construction of two main or trunk roads, one along the coast and the other traversing the great Sacramento and San Joaquin valleys.

Second—That the county seats of such counties as lie east and west of the trunk lines shall be connected to the trunk lines by lateral and tributary highways.

Third—That in interpreting that part of Section 4 of the "State Highways Act," which covers the selection of routes, that the emphasis is to be placed upon the expression "by the most direct and practicable route," and that these words are the controlling words of the statute.

Fourth—That the object of the statute, in so far as the two trunk lines are concerned, is by directness to afford a means of communication so that the people of the north may be in touch with the people of the south in the shortest interval of time and space, and at the same time linking together those county seats and centers of population which can practicably, and without materially sacrificing directness, be so joined in a trunk line running north and south through the State.

Fifth—That the connection of county seats and centers of population by the trunk lines is not the primary but a secondary consideration, and they should be so included in the trunk lines only when their inclusion would obviously not sacrifice directness and practicability in the trunk lines.

Sixth—That the "State Highways Act" provides for two north and south trunk lines through the State, and, in a state so much longer than it is wide, it is obvious that such trunk lines must be as direct as possible to bring the several parts of the State into the closest possible communication. That such trunk lines must be considered from a state-wide aspect is apparent, and local needs and conveniences and advancement should not be the determining factors in the selection of "direct and practicable" routes; that county lines are to be obliterated in the determination of the legal and logical trunk lines.

Seventh—That laterals are provided for in the "State Highways Act" for the express purpose of furnishing ingress and egress to and from the trunk lines for such county seats as can not practicably be reached by a direct trunk line; and that the ultimate scheme of the state highway system is to cover the State of California with a network of highways which will compact the whole State for the purpose of intercommunication of the residents of every part of the State, and so that no longer will counties be spoken of as being "remote or inaccessible."

Eighth—That the voting of the limited sum of $18,000,000 for the system of state highways specified in the act precludes any other idea than that the routes chosen must be direct and not meandering, and that the saving of mileage is the essence of the act.

Ninth—That it was neither contemplated by the "State Highways Act" that local traffic demands should be considered in the routing of the state highways, nor that such state highways should be built primarily as feeders to carry local produce to local transportation depots and home markets.

If the act was intended for this purpose, then the effect of the word "direct" used in reference to trunk lines would necessarily be nullified, and the Department of Engineering would have to transform itself into a body of statisticians in order to determine the relative advantages of the various local communities, and while it was engrossed in the task of solving these vexing problems, new "centers of population" would spring into being as is their habit in the rapidly growing State of California. That an emphasis on local needs would necessarily produce irreconcilable conflicts and complications between the rival centers, with which it is unreasonable to assume that the framers of the "State Highways Act" ever intended to perplex state officials, because they are essentially matters to be handled by county or municipal authorities, who are the proper public officials to solve local problems.

Tenth—That no state highway, either trunk or lateral, should be materially deflected to include a "center of population," and that the placing of centers of population on the trunk lines must not be done at the expense of several additional miles of highway construction.

Eleventh—That the expression "along the Pacific coast" does not mean a literal "shore line," but is used in a most general sense, just as "traversing the Sacramento and San Joaquin valleys" is used in terms as broad as those great valleys themselves.

That the words "along the Pacific coast" are used with the meaning of traversing the Pacific coast, but in order to make the phrase somewhat clearer, the term "along" was used in a most general sense, namely, "in line with the length of," and not in the sense of "immediately by the side of the shore."

That in attempting to build a "literal shore line" road up and down the Pacific coast, the Department of Engineering would not only sacrifice "directness and practicability," the prime factors in the law, and leave several county seats off the trunk highway, but would incur the ridicule of the thinking people of the State and deplete the $18,000,000 fund without a proportional showing of results.

Twelfth—That each and every recommendation made to the Department of Engineering, relative to directness and practicability from an engineering standpoint, has not only been personally investigated and approved by at least two members of the Commission, but also by the Highway Engineer and by the Division Engineer of the division in which the proposed route is situated, and if such route lies within two divisions, then, by the two Division Engineers of such two divisions.

Thirteenth—That the matter of routes is largely a matter of the sound discretion of the Department of Engineering, and a finding based upon the considerations herein stated will not be held by any court to be an abuse of discretion.

Fourteenth—That the Commission has been guided in its recommendations in matters of law by an opinion furnished by the Attorney General of California, the legal adviser of the Department of Engineering, dated August 22, 1912, to which the attention of the reader is respectfully directed, and with which opinion the recommendations of the Commission in the matter of routes have strictly conformed.

The Commission has had before it for determination several cases illustrating the points mentioned above, the most troublesome of which were the VISALIA-HANFORD; the TEJON-TEHACHAPI; the SAN JUAN-WATSONVILLE and the ZACA CANYON-ALISAL controversies. In each of these cases much factional feeling has developed and the contentions have been bitter. Each will be discussed briefly.

Visalia-Hanford vs. Selma-Tulare City Route (see Frontispiece).

In this case, after much study, the Commission determined that the state highway should follow substantially the main line of the Southern Pacific Railroad between Fresno and Bakersfield with laterals connecting with Visalia and Hanford, two county seats which would not be touched by the main line. The opposition as at present constituted to this route desires the main road to extend from Fresno to Fowler, thence to Hanford, thence to Visalia, thence via Exeter, Lindsay and Porterville to a connection with the main line near Famoso, about 20 miles north of Bakersfield.

The line recommended by the Commission traverses the trough of the San Joaquin Valley and the chief reasons for its selection are as follows:

1. It is the most direct and practicable route connecting the two largest centers of population in the valley.

2. The line is an average line permitting the communities on both sides of it to reach it by laterals with the least expense.

The local traffic is well cared for by this route. Between Visalia and Fresno and between Hanford and Tulare the Commission's line best serves such traffic. On the other hand, the line of the opponents serves the local traffic better between Fresno and Hanford.

The line originally recommended by the Hanford and Visalia people, not considering the Porterville detour, leaves such thriving towns as Selma and Kingsburg entirely to one side, and leaves Reedley and Dinuba farther away from the state highway than does the line recommended by the Commission.

All through traffic would be burdened by at least an additional 17 miles which it would be forced to travel, *i. e.*, all of the travel originating

any where in the State of California south of Tulare, going to any where in the State north of Fowler, would be inconvenienced to the extent of having to travel 17 additional miles.

If the Porterville detour be also considered, all of the travel originating any where in the State south of Famoso and traveling to any point in the State north of Fowler, would have to travel 30 additional miles. All travel from the north to the south would be burdened in like manner.

The detour by way of Porterville would leave out of consideration the town of Corcoran, and all of the oil fields of the extreme west side of the valley, and would force the highway up against the eastern fringe of the valley, a location manifestly unjust to the remainder of the valley.

The city of Tulare, and Tipton, Pixley, Earlimart and Delano would be left off the state highway.

A short distance to the southwest of Tulare lies the rich alfalfa district, the local center of which is Corcoran, considered to be one of the

through Kings or Tulare counties. Everywhere else there was a predominance of argument one way or the other, and an intelligent decision could be reached. There were local disappointments, but no sense of irreconcilable injustice. But through this one stretch, no possible decision could have been made without doing injustice to somebody. There is, in the tier of counties south of Fresno, a bifurcation of population, of county government, and county seats, which gives each side equal claims to recognition. The railroads have met the situation in the only possible way—by two roads. The only way the Highway Commissioners could have done local justice would have been to do the same thing—build two roads. But they have not money enough for that, and they could not justly have granted it in this one place while denying it everywhere else. They had to choose one route, and whichever decision they made was necessarily wrong. They finally made their choice—the wrong one, of course, but either of the others would have been wrong also. And the Governor quite properly lets their decision stand. If he had overruled it, he could only have substituted one wrong road

Typical Views, Tejon-Castaic Route, State Highway Survey.

greatest in the State, and this district would not be served by the Porterville route.

In a general way, it would appear that a line which would serve with justice the entire San Joaquin Valley should be a direct line traversing the trough of that valley, and leaving the communities through which it does not pass to reach it by a system of laterals. The line adopted by the Commission meets this requirement.

It is apparent that the cost of construction would be considerably less by way of the route selected by the Commission, owing to its proximity to the railroad, thus obviating long wagon hauls of material of construction.

An editorial published recently in the Fresno *Republican*, a portion of which is quoted below, is a somewhat facetious but nevertheless correct statement of the difficulties in the choice of this route:

"* * * The only absolutely insolvable puzzle passed up to the Highway Commission was the routing of the road south of Fresno for another, while adding the additional governmental wrong of undermining a condition which ought to be independent.

"The only right solution is two roads and the State can not provide that. The next best thing would be for the State to flip a coin, for one way or the other, the counties to supply whichever road the State did not. But that would require the county which received the State road to contribute half the expenses of a county road in another county—which the people might refuse to authorize even if there were a law for it. * * * "

Tejon-Tehachapi Controversy (see Frontispiece).

For the state highway between Los Angeles and Bakersfield the Commission has recommended a line beginning at a point near Newhall, about 32 miles northwesterly of Los Angeles, and extending thence via the Castaic Ridge and the so-called Tejon Pass to Bakersfield. This line has been generally called the "Tejon Route." The opponents to this route recommend a line beginning at or near Newhall and extend-

ing via Mint Canyon, Lancaster, Mojave, thence over the Tehachapi Range through Tehachapi passing near Caliente, and over the White Wolf Grade to Bakersfield, following substantially the route marked by the dotted line on the map on the front page.

After investigating both routes the Commission recommended the route indicated by the heavy black line chiefly for the following reasons:

Tejon-Castaic Ridge Route, Los Angeles County, State Highway Survey.

1. It is the most direct and practicable route connecting Los Angeles with Bakersfield, it being approximately 115 miles in length as against about 175 miles by way of the opponent's suggested line, a difference of approximately 60 miles in favor of the Commission route.

2. While the Tejon summit and the Tehachapi summit are of about the same elevation, it is possible to secure much easier grades and alignment via the Tejon than via Tehachapi. There will be only 3 miles of 6 per cent maximum grade throughout the Tejon route.

3. The Tejon route better serves the west end of Antelope Valley where there are thousands of acres of land suited to agricultural uses, and places in closer touch the oil district southwest of Bakersfield with its natural center at Los Angeles.

4. The drainage is far better on the Tejon route, the Antelope Valley between Lancaster and Mojave being little better than a sink in times of wet weather. Wind conditions at Mojave are as severe as anywhere in the State, at times, and the desert traversed for a great distance on the Tehachapi route is not encountered on the Tejon line.

5. The creek crossings are fewer by 30 than on the opponent's route and the cost of maintenance will be less. No argument is needed to show the vast saving in cost of construction which will result from the saving of 60 miles in length. There is no serious engineering difficulty in its construction.

The shorter line will bond together the great San Joaquin Valley and Los Angeles and her tributary valleys and encourage travel, traffic, and intercommunication. The longer line would discourage travel and separate communities, and place a burden of 60 miles or more on every traveler who would ever travel this road, with the exception of persons going to the easterly part of Antelope Valley.

The population which would be served by the Tehachapi route has been variously estimated at from 1,500 to 2,000 persons. Should the great city of Los Angeles and the prosperous and growing city of Bakersfield, with a population in 1910 of 12,727, be pushed farther apart for all time by 60 miles of state highway more than is needed to connect them, solely because of the local needs of the sparsely settled Antelope Valley?

The Tejon route brings southern California and the great San Joaquin Valley nearer to each other politically and commercially. It would serve as a perpetual and powerful influence in removing sectional prejudices between the north and the south, and would to that extent serve to promote the unity and integrity of California as a State, and discourage the agitation for state division.

San Juan-Watsonville Controversy (see map opposite).

The route recommended by the Commission for the state highway between San Jose and Salinas passes through Gilroy, Sargent, Betabel, and San Juan, thence over San Juan Mountain to Salinas.

The opponents of this route, chiefly residents of Watsonville, a thriving city of Santa Cruz County, and the people of the northwestern part of Monterey County, ask to have the state highway diverted at Betabel or nearby, and extended thence along the Pajaro River, through or near Chittenden to Watsonville; thence southerly through Castroville to Salinas. (See dotted line on accompanying map.)

The chief reasons of the Commission for recommending the San Juan route are as follows:

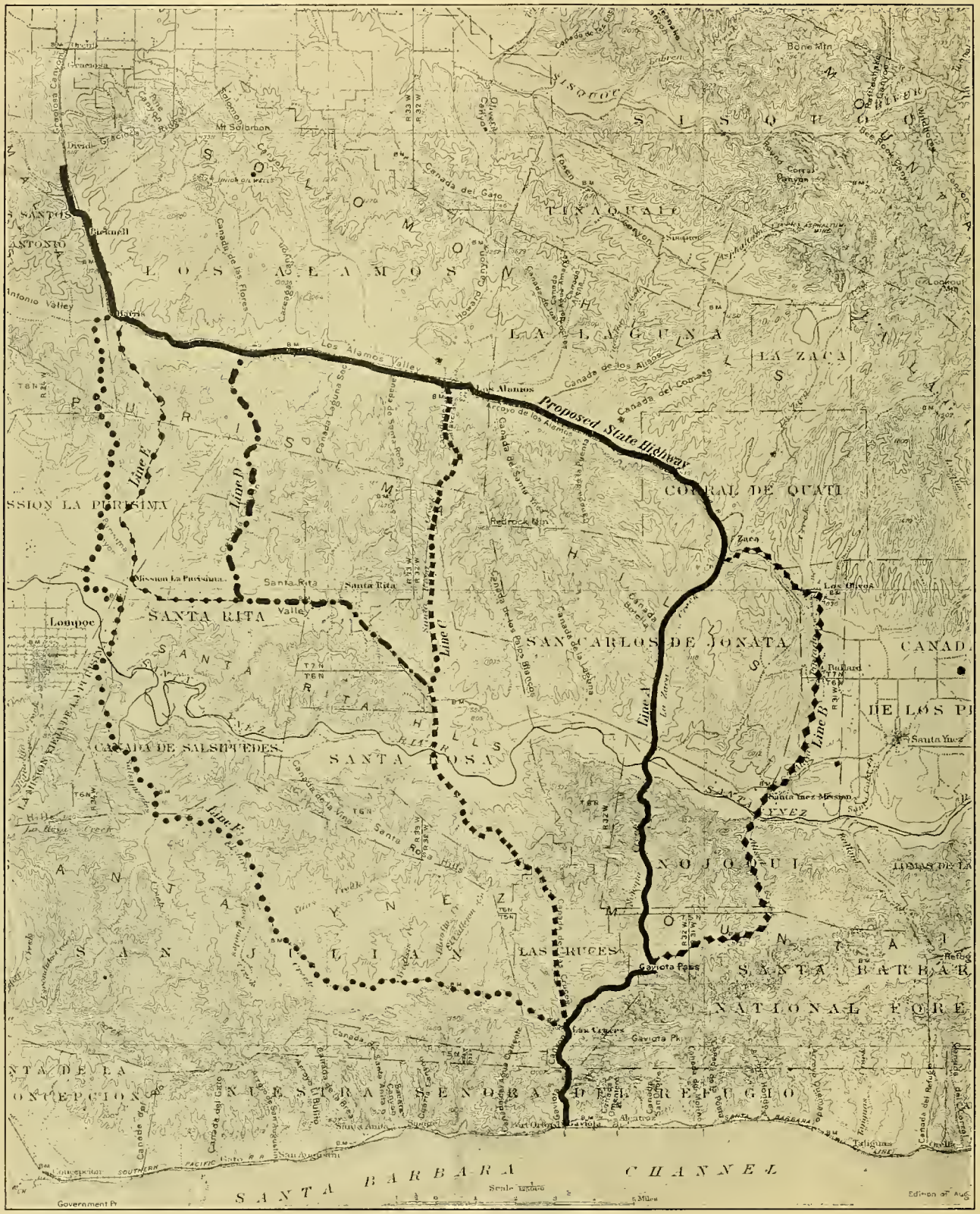
1. It is the most direct and practicable route between the lower end of the Santa Clara Valley and Salinas, the county seat of Monterey County, it being at least 15 miles shorter than the opponent's line via Watsonville. Salinas is on the natural route for travel.

2. The town of Hollister, county seat of San Benito County, must be connected with the trunk line. This lateral, 7 miles in length, can be constructed at the least cost by tying it to the Commission's line at San Juan and to the greatest advantage to Hollister and San Benito County. If the state highway passed through Watsonville the connecting lateral would be 11 miles long. Hollister is a county seat, while Watsonville is not.

3. Notwithstanding the miserable road now existing over San Juan Mountain, most of the travel follows that route because of its directness. The road planned by the Commission will have only one mile of 6 per cent grade, the balance varying from 2 to 4 per cent.

The road proposed via Watsonville passes along the bank of the Pajaro River for some distance. The road there is menaced constantly by a bad "slide" resulting from a "fault" in the strata of the hill on one side and by the river on the other, which

Showing San Juan Route and the Opposing Riverside-Watsonville Route.



Various Santa Barbara County Routes vs. The Zaca Canyon Route.

erodes the bank to such an extent that piles and bulkheads have been placed to protect it. The road here has been destroyed more than once from these causes.

Zaca Canyon-Alisal Controversy (see map, page 10).

The routes in Santa Barbara County between Santa Maria and Gaviota have been given a great deal of consideration by the Commission and after several months of study and after many miles of preliminary survey the line marked "Line A" on the accompanying map is recommended. This line passes through or near Bicknell, Harris, Los Alamos, Zaca Station, and thence southerly via the Zaca and Nojoqui creeks, Nojoqui Hill to Las Cruces, thence through Gaviota Pass to the coast.

Lompoc, a rapidly growing community, wished to have the state highway touch the town or pass as near to it as possible. Residents of the city of Santa Barbara and the little settlements between Los Olivos and Santa Ynez wished to have the road extend to the east from Zaca Station, passing through Los Olivos, Ballard, Santa Ynez Mission, thence by the Alisal Grade to Gaviota Pass (see "Line B").

The chief reasons which moved the Commission to recommend the Zaca Canyon line are as follows:

1. It is the most direct and practicable route between Harris and Gaviota Pass. It is not the shortest, being about 4 miles longer than the shortest route through the mountain passes, but the adopted line will have but 2.5 miles of grade in excess of 5 per cent, while the shortest line ("Line D") would have 7.5 miles in excess of 5 per cent. It is 4.5 miles shorter than the Los Olivos-Alisal line ("Line B") and will have one mile less of grade in excess of 5 per cent. "Line B" was the second choice of the Commission and only after much debate was it discarded.

2. This location enables the town of Lompoc to make a connection with the state highway more easily than it could with the Los Olivos-Alisal line, and reasonably well satisfied the desires of that town. The lateral will follow the Santa Ynez River by easy grades.

3. The presence of good local material for road construction and the delivery of materials from the railroad to Zaca Station, the downhill haul and easy grades, will greatly lessen the cost of the work as compared with any other route.

4. A dangerous grade crossing, about one mile west of Los Olivos, will be obviated as will also a 12 per cent grade in the same locality.

Naturally, there is objection by residents of Los Olivos, Ballard, and Santa Ynez to the construction of a new road which will doubtless be used by the traffic now passing through these settlements. The largest of these places is Los Olivos, itself but a small place (population, census of 1910, 220). From Zaca Station to Los Olivos is but 3 miles.

The adoption of the Commission's route entails the construction of a bridge about 1,000 feet in length over the Santa Ynez River. On the Los Olivos-Alisal line over the same river there is now a bridge of about the same span and of the type known as "combination wood and steel." This bridge will last but a few years, and the new bridge on the Zaca route will take its place.

The bridge question should not control when better alignment, better grades and four and one half miles saving in distance may be secured by the route proposed by the Commission.

IN CONCLUSION.

The foregoing statement sets forth some of the potent legal and practical reasons for the action of the Commission in presenting such recommendations. The fundamental issues may be summarized as follows:

1. Are directness and practicability the main factors?

2. Or, on the contrary, is the placing of a county seat or county seats on a trunk line, even at the expense of a number of additional miles, the primary consideration?

3. Shall the route of a trunk line be deflected, even though considerable distance is added, in order to connect the present center or centers of population numbering from a few hundred to a few thousand people?

4. Shall the plan of routing the entire system be based upon the needs of the State as a whole and its relation to neighboring states, or shall the emphasis be placed upon the local needs of the counties traversed?

GOVERNOR HEARS THE COMPLAINING CONTRACTORS

Investigates Road Making Costs and Methods, and Approves Commission's Work

On March 21st, Governor Johnson heard the complaint of a number of contractors who do city paving work, in a large way, who alleged in an open letter dated February 7th that the thin bituminous wearing surface which the Commission has specified for about 100 miles of the state highway was not "permanent" and advocated a wearing surface of bituminous material not less than 2 inches thick.

The state highways referred to are paved with a concrete base of a minimum thickness of 4 inches and 15 feet wide. Shoulders at least 3 feet wide are built on each side of the concrete. The concrete base is covered with a thin coating of asphaltic oil of special quality and stone screenings forming a bituminous carpet from three eighths to one half inch in thickness to serve as a wearing surface and to protect the concrete.

Crude Oil versus Asphalt.

The contractors' letter was published widely in the public press. A portion of it is here quoted:

> * * * We marvel that the state highways of our own State are using crude oil and a small layer of screened rock, three eighths of an inch in thickness as an alleged wearing surface. We submit that crude oil, even though containing eighty per cent of asphalt, is not in any sense a cement and will be of very little value to care for the wear to which our roads are subjected, and that the mode of its application is also crude and far from being mechanically or scientifically exact; and we desire to quote the Chief Engineer of the Highway Commission—that "it is not permanent."
>
> We wish to go on record as practical road builders that the cost of such construction and its maintenance for a period of ten years will far exceed in cost a permanent, scientifically constructed pavement such as recommended by your petitioners.
>
> We believe that the questions above outlined are among the most important now confronting your administration, and the wise disposition of them will go further than anything else to bring lasting credit to it. * * *

At the hearing the contractors were well represented by several of the firms signing the letter. The three members of the California Highway Commission and the Highway Engineer were present.

No Fault With Our Cement Base.

By a few direct questions the Governor established the fact that the contractors had no fault to find with the Portland cement concrete base adopted by the Commission for the main lines of travel and they made no criticism of that feature of the work other than that under some conditions the "cement base" might be unnecessarily expensive and a bituminous concrete base equally satisfactory.

The issue was thus narrowed to the wearing surface, which the contractors had declared in their letter should be not less than 2 inches in thickness.

The contractors admitted that 6 cents per square foot (54 cents per square yard) was as low a price as could be expected for from 1½ inches to 2 inches of bituminous wearing surface whether it be of the sheet asphalt type or of one of the variants of "bitulithic" and the Highway Engineer stated that the thin bituminous surface was costing less than 5 cents per square yard on the work under contract, so that it was clear that the wearing surface demanded by the contractors would cost more than ten times as much as the type adopted by the Commission (Commission's type, $440 per mile; contractors' type, $4,752 per mile).

Mileage of the Highway System.

Asked what the Commission's estimates were as to mileage of roads to be built under the bond issue of $18,000,000 and the cost estimates for the work, the Highway Engineer presented the following tabulation:

Trunk Lines:	
1,305 miles, requiring paving, at $8,620	$11,249,245 00
480 miles surfaced with local materials, at $5,944	2,852,905 00
Laterals:	
785 miles at $2,881	2,261,485 00
Improved county roads, 190 miles, at 0	0
Add 10 per cent for administration, surveys and engineering	1,636,364 00
Total bond issue	$18,000,000 00

Total mileage, 2,760 miles.

The engineer explained that the figures of mileage were tolerably accurate but that the average prices per mile were rough only.

The thin wearing surface roads, on the basis of the 100 miles under contract, are costing about $7,600 per mile, this cost being made up approximately as follows:

Grading, culverts, etc., per mile	$1,300 00	17.1 per cent
4 inch concrete base, per mile	5,860 00	77.1 per cent
⅜ inch bituminous wearing surface, per mile	440 00	5.8 per cent
	$7,600.00	

Prohibitive Increase of Costs.

It was shown that if the thick wearing surface (1½ to 2 inches) were placed on the concrete bases the cost of these roads would be increased by $4,312 per mile, making them cost $11,912 or roughly $12,000 per mile.

Thus on the basis of 1,305 miles of main trunk lines requiring paving, if surfaced as recommended by the contractors, the cost would be $15,660,000, without considering any expenses of administration, surveys, and engineering. Adding 10 per cent for these items the 1,305 miles would cost $17,226,000. In other words, 47 per cent of the mileage

Concrete Road, Armored Joints, No Wearing Surface, Wayne County, Mich.

required to be built under the law would consume more than 95 per cent of the whole bond issue.

The contractors agreed that the highway system could not be completed within the amount of the bond issue if their type of paving were adopted for the standard.

Experience of Eastern Road Builders.

Doubt was expressed by the contractors if the Commission type of wearing surface would have a life exceeding six months and the Highway Engineer recited the experience of the Eastern States in the use of

Concrete Base with Bituminized Top, Ann Arbor, Michigan.

bitumen and screenings for wearing surfaces on macadam and on concrete where the traffic is vastly in excess of that over the roads which the Commission is building and where the climatic conditions are far more severe than in California. He asserted that upon the Eastern precedents he estimated that the thin surfacings would last from one to three years and that in his judgment it was safe to estimate an average life of two years under California conditions. That re-treatments would not cost more than 5 cents per square yard and that on the basis of a re-treatment every two years the maintenance cost of the wearing surface would be $220 per mile per year. He also stated that the grading, culverts, and concrete base represented more than 94 per cent of the total cost and that these features were "permanent."

Interest Charges Exceed Maintenance Costs.

The Highway Engineer called attention to the fact that the interest on the excess cost of the thicker surfacing ($4,312 per mile) at 4 per cent per annum would nearly if not quite take care of the maintenance of the thin surface adopted by the Commission.

The Commissioners spoke in favor of the concrete base with the thin surface, dwelling upon the small percentage of the total cost represented in the wearing surface and calling attention to the fact that at any time in the future when the traffic requires a more substantial pavement, a

Concrete Road, Thin Bituminous Top, State Highway, Spencer, Mass.

thick wearing surface may be put on the present concrete base without loss.

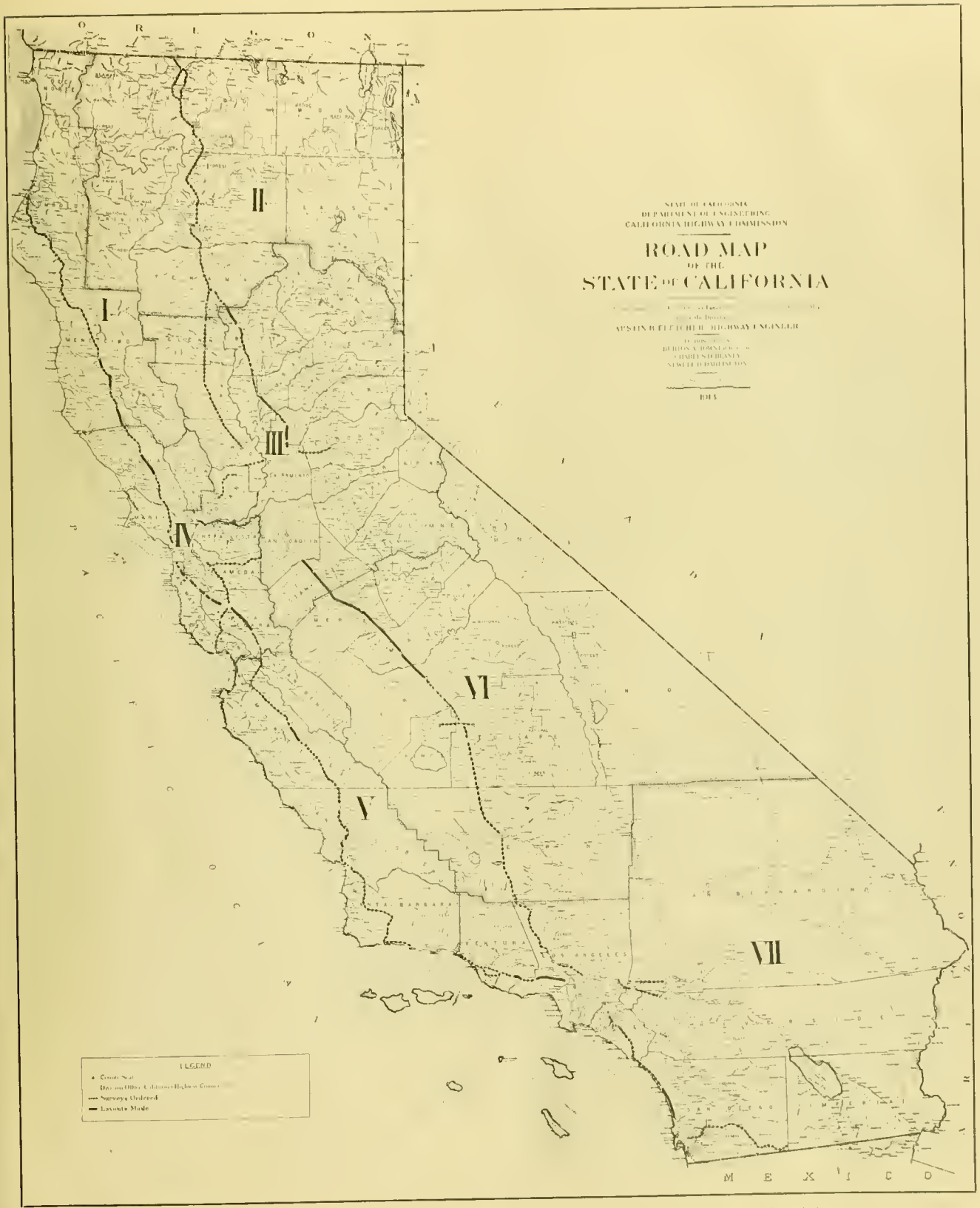
What the Governor Said.

During the progress of the discussion the Governor paid the organization of the Highway Commission a high tribute and expressed his confidence in the efficiency and fidelity of this body. To one of the contractors he said, "Your proposition would forbid our finishing the work under the State Highways Act. In effect you ask that certain portions of the State shall be favored and certain other sections neglected."

Concrete Street, Thin Bituminous Top, Ann Arbor, Michigan.

The Governor ended the discussion by declaring that he cordially endorsed the policy of the Highway Commission in endeavoring to administer the eighteen million dollar fund equitably and fairly for all sections of the State and that it would be manifestly unjust as well as illegal to give certain sections the benefit of this fund and to tell the people of other localities to wait and take their chances on a possible second bond issue.

The West Side Counties Association, of which Mr. D. W. Ross of Red Bluff is President, representing Tehama, Colusa, Glenn, Yolo and Solano counties, is making an organized campaign to buy highway bonds enough to build the state highway from Davis to Red Bluff.



Map Showing Location of All Surveys Ordered; Also All Layouts Made by the California Highway Commission.

STATE HIGHWAY CONSTRUCTION SEVERELY TESTED

The Four-Inch Base is Undermined, and Yet Supports Ten-Ton Road Roller

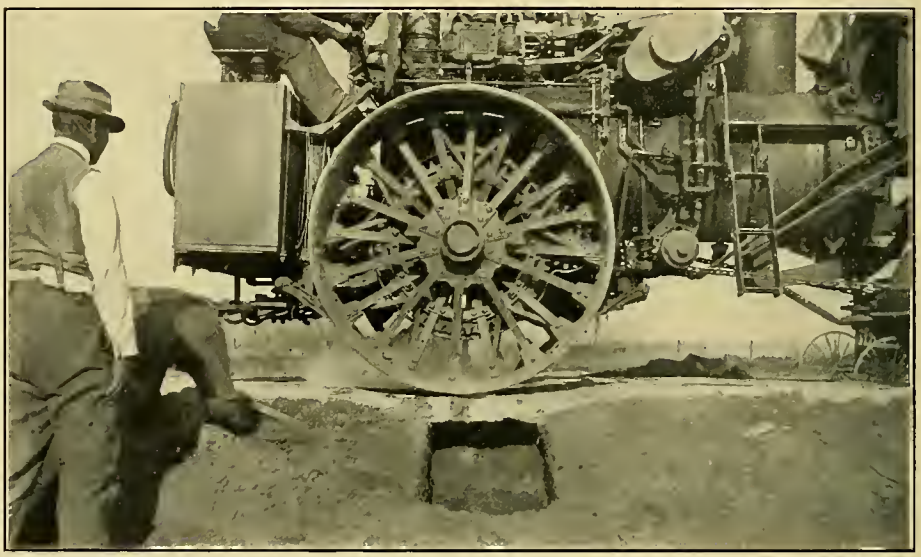
On some one hundred miles of the California State Highway, now under contract, a concrete base composed of broken stone, sand and cement has been specified of a minimum thickness of four inches. Provision is made in the contracts that whenever it appears to the Highway Engineer that the sub-grade is not suitable the concrete base shall be increased in thickness at his discretion.

The specifications call for a rich mixture of concrete, consisting of one part of Portland cement, two and one half parts of sand and five parts of broken stone. One and three tenths barrels of cement are actually being used to each cubic yard of concrete in this work, and an unusual strength should be expected.

The question has been asked whether a concrete pavement of the type referred to has sufficient strength under traffic to successfully span possible burrows by animals, or old trenches which settle subsequent to the building of the road.

To demonstrate its strength, some crude tests were recently made on the highway leading to the north from Fresno City. The concrete at this place was thirty-five days old at the time of the tests, but no bituminous wearing surface had been applied.

Before the tests, the supporting earth was removed from under the concrete for a width of two feet and extending in four feet from the edge of the concrete. The tests were made with a so-called ten-ton Kelly-Springfield roller, which is so designed that one third of the load is on each rear wheel. The rear wheels are twenty inches wide.



Testing Four-inch Base, State Highway.

In the first test the roller was run along the road, its rear wheel crossing the unsupported concrete twelve inches clear of the edge of the pavement.

The second test was like the first, except that the wheel was but six inches clear of the edge of the pavement.

In the third test the roller was stopped and started with the rear wheel on the unsupported concrete, six inches from the edge of the pavement. There was no noticeable effect on the concrete in any of the first three tests.

In the fourth test the wheel was passed over the unsupported concrete with its side even with the edge of the pavement, and in the fifth it was made to pass over a block of wood, 2 inches by 4 inches by 8 inches, laid flat, twelve inches from the edge of the pavement and lengthwise with the road. A slight deflection was noticeable in both the fourth and fifth tests as the roller passed over the opening, but the concrete regained its original position immediately after the passing of the roller.

Assuming that the weight on the block of wood was three and one third tons only (weight probably nearer 4 tons since the roller was supplied with water and fuel), the load in the fifth test was equivalent to 1,666 pounds per inch of width of bearing. Looking at it another way, the concentrated load was the equivalent of a wagon with four wheels, each with 4-inch tires, carrying a load of 13 tons equally distributed over the four wheels.

The heaviest load likely to pass over the state highways is the 20-ton traction engine. Assuming that the two rear wheels carry two thirds of the weight, each wheel would carry 13,300 pounds, and if the wheels are only twenty-four inches wide, the weight per inch of bearing is 550 pounds per inch. The weight used in the tests, therefore, was more than three times as great per inch of width of tire as the heaviest load to which the pavement is likely to be subjected.

As a final test, the block of wood was moved to within six inches of the edge of the pavement, so that when the roller wheel ran up on the block it overhung the edge of the concrete by about 2 inches. In this position the combined weight and the shock due to running the roller on to the block cracked the pavement.

WORK OF THE HIGHWAY COMMISSION'S TESTING LABORATORY

All Road Building Materials Used on the State Highway are Scientifically Examined

By C. B. Osborne, Chief Geologist

The great variety of materials used in the construction of the roads being built by the California Highway Commission has made it necessary to install at Sacramento a laboratory equipped to test oil, asphalt, cement, rock, sand, and gravel.

Laboratories, State Highway Commission.

Two small buildings have been built near the north end of the State Fair grounds. These are shown in the accompanying photograph. In the frame building are housed all the heavy machines for the testing of rock, sand, gravel and cement. The chemical testing and the oil and asphalt tests are carried on in the hollow tile building shown in the foreground of the photograph. This building is designed to give as far as possible proper temperature conditions for the laboratory test of oil and asphalt.

At the laboratory, tests are made to determine the material best suited for the construction and also to furnish exact data as to what material submitted passes the specifications adopted and what material has to be rejected because of failure to pass the requirements.

In the testing of Portland cement the specifications of the American Society of Civil Engineers have been adopted and the cement before being used is given a complete test for its strength both in the neat and also in a concrete mixture; for its constancy of volume in steam and water tests; and its fineness and specific gravity is also determined. The sieving test is made on samples of the sand and gravel or crushed

rock used in the concrete and in this way the proper proportions of cement, sand and rock are found to give the maximum strength. The sand is also mixed with cement in the same proportion as with Standard sand and any concrete failing to show less than 70 per cent of the strength of Standard sand concrete is rejected.

When rock is to be used for macadam or for the wearing surface on the road, a sample is taken and tested in the Duval rattler for its loss in abrasion. This is the test used by the Department of Agriculture in the office of Public Roads. In this test 50 pieces of rock weighing 5 kilograms (about 11 pounds) are placed in an iron cylinder and turned for 10,000 revolutions at the rate of 2,000 revolutions per hour. The rock falls from one end of the cylinder to the other and wears on itself and on the sides of the cylinder. If the rock loses more than 2.9 per cent in this test it fails to pass the requirements. In this way, the rock used is known to possess a high resistance to wear. The rock is also examined for any minerals that on weathering would tend to weaken the road.

The asphalt to be used is tested for its purity by the percentage solvent in CS_2 and CCl_4 and in this way can be shown whether or not the asphalt has been overheated and ruined in driving off the lighter oils. The hardness of the asphalt is determined by use of the penetration test.

When sheet asphalt pavements are being laid samples are taken each day and tested for percentage of sand and asphalt and in this way the proper mixture to give the best result is controlled.

The purity of the road oils used is determined by the following tests: the percentage soluble in carbon bisulphide, carbon tetrachloride, and in 86° naphtha; the percentage of water, sediment, fixed carbon and ash in the road oil is found; the lighter oils are driven off in a New York Testing Oven at a temperature of 400° F. until an asphalt of 80° penetration remains and this gives the per cent of asphalt contained in the oil; the temperature of the flash point and the burning point of the oil is taken to show if the oil is a mixture of light and heavy oils and also to find the safe limits to which it can be heated for application on the road.

The oil is tested for its physical properties by the Engler viscosimeter and the Float test. These tests show the rate of flow of the oil through a cylinder of a given size at a given temperature. These tests are made according to the methods described in Bulletin No. 38 of the Office of Public Roads of the U. S. Department of Agriculture. The results are of value in showing the relative viscosity or "body" of the road oil.

The binding or sticky property of the road oils is determined by the Osborne Adhesion test.

In addition to the tests already mentioned that form the routine work of the testing laboratory special tests are made to find the value of

Commission's Testing Laboratory.

different road materials, the good and bad effects of salts, alkalies, and acids on the concrete and oil where the roads are to be built in localities presenting unusual conditions.

THE "STICKY" TEST FOR BITUMENS.

Oil has been used as a dust preventive and binder in road construction for a long period of years and has become especially important since the automobile has made necessary the use of a strong binding cement on the wearing surface of a road.

The testing of oil for road work has grown up slowly with the more extensive use of oil in road construction and there is a very great variety of tests required by different road engineers.

There are a great many different types of viscosimeters in use to determine the "body" or viscous property of an oil at different temperatures. Those machines measure the rate at which the oil will move through an opening of a given size. The test is of value in showing the cohesive property of the oil, that is, the measure of its power to prevent a change in its shape. When an oil is very viscous it is said to have "body."

Commission's Chemical Laboratory.

Oils known to be very viscous are often sticky and some test for viscosity is often adopted to aid in getting a good binder for the roads. This test is not a sure test for a sticky oil, however, as it would be possible to get a road oil of the same viscosity as a heavy machine grease and yet while the one might have good binding properties, the other would be a lubricant of no binding value in road work. Road oils may often have "body" and yet carry a high percentage of lubricating oils. If such an oil is used it can easily be understood why the oil would fail as a binder.

A novel machine designed by Chief Geologist Osborne, which measures scientifically the comparative adhesive qualities of various oils, is in operation in the laboratory.

This adhesion test gives new information regarding road oils and promises to offer a great aid in measuring the "stickiness" or binding strength of a road oil, which is its most important property.

ACROSS THE YOLO BASIN

An extremely important link in the state highway system is the proposed road and causeway between Sacramento and Davis, in Yolo County. In going from Sacramento to San Francisco by the highway, at the present time, a circuitous route by way of Stockton must be taken, making the total length of the journey about 130 miles.

There is now no crossing across the Sacramento River north of Sacramento, except for about three months in the fall of the year, until one reaches Meridian Ferry, a point about 18 miles west of Marysville. One must travel not less than 70 miles from Sacramento to reach that ferry.

Thus communication by wagon road between the rapidly growing and prosperous sections on the west side of the Sacramento River in Yolo, Colusa, and Glenn counties, with Sacramento, the capital of the State is to all intents and purposes, cut off.

From Sacramento to Davis is about 12.8 miles, but the cost of bridging the great Yolo Basin, which receives the overflow of the Sacramento River, has heretofore prevented the construction of this important road.

During the coming year the Commission hopes to let contracts for the construction of this link. Not less than 12,000 feet of trestle work will be required and there will be much heavy grading.

The Sacramento associated banks are now considering the purchase of state highway bonds to the extent of about $400,000 to provide the funds needed for the work.

When this link is completed, not only will the west side counties be able to reach the state capital conveniently, but the distance between Sacramento and San Francisco will be reduced from 130 to about 100 miles.

DETAILED PROGRESS REPORT OF THE STATE HIGHWAY WORK

Twenty-nine Contracts Let, Many Layouts Ready, Surveys Going Forward Rapidly

As shown by the table below, routes 9*a*, 10, 11 and 12, aggregating 214 miles, have been added to the state highway system since the issue of this Bulletin last October.

Concrete Mixer, State Highway, near Roseville.

This increased mileage on account of these routes, however, has been nearly offset by the reduced length of portions of the old routes as determined by the surveys, as follows:

Route 1, reduced 11 miles; route 2, 57 miles; route 3, 34 miles; route 4, 55 miles; route 5, 8 miles; route 7, 36 miles—a total reduced mileage of old routes of 201 miles.

These twelve routes are described as follows:

Route 1.	San Francisco to Oregon line	410 miles
Route 2.	San Francisco to San Diego via Los Angeles	535 miles
Route 3.	Sacramento to Oregon via east side Redding	310 miles
Route 4.	Sacramento to Los Angeles via San Joaquin Valley	390 miles
Route 5.	Stockton to Santa Cruz via Oakland	125 miles
Route 6.	Sacramento to Woodland Junction	20 miles
Route 7.	Tehama to Benicia	155 miles
Route 8.	Hopland to Vallejo via Lake County	107 miles
Route 9. / Route 9*a*	San Fernando to San Bernardino and Riverside	105 miles
Route 10.	Hanford to Visalia	20 miles
Route 11.	Folsom to Placerville	30 miles
Route 12.	San Diego to El Centro	105 miles
		2,312 miles

To date, the number of layouts is 38, aggregating a total length of 280 miles.

The number of road contracts to date is 29 and their aggregate length is 206 miles, and their total cost will be $1,753,748.

In engineering parlance, a "layout" is a portion of the state highway, the location of which and the plans for which have been formally approved.

These layouts, therefore, are the net result of months of field and office work. The man behind the axe, fighting his way through the brush, the man with the tape measuring base lines across creeks and along hillsides, the man behind the tripod with his note book full of

Unloading Broken Stone from Cars on State Highway near Madera.

figures and sketches, and finally the draftsman bending over his table, tracing the plans with pen in hand and a pain in the back, all perform an essential portion of the labor that produces the layout.

The accumulated layouts, therefore, which the Commission has not yet submitted to contractors are simply the depressing evidences of the fact that the work of the Commission has been clogged by the stagnant condition of the bond market.

Layout 13, 4.4 miles, Ventura County, and Layout 25, 7.3 miles, Monterey County, are dormant because there is no money to prosecute their construction.

In addition there is Layout 20, of 11.2 miles in Butte County, and Layout 24, of 6.4 miles in San Luis Obispo County. Bids for these have been received and rejected, and the work cannot be readvertised because of want of funds.

Layout 26, of 10.4 miles in San Diego County, and Layout 18, of 14.2 miles in Merced County have been submitted to contractors and bids for the same were received on November 18, 1912. On account of the lack of available funds, the Commission has not been able to award these contracts.

But this is not all. Over 200 miles of layouts in embryo are practically

Concrete Base, Bituminous Surface, State Highway, near Roseville.

worked up and can be made ready for the Commission's attention at once. They are scattered throughout a dozen counties. The only reason why they have not been offered by the Highway Engineer for approval is that there is no money on hand for the work of construction in these particular counties.

Of the 1,700 miles of surveys which the Commission has already ordered, 1,200 miles have been completed. In addition thereto, the abandoned surveys and reconnaissances aggregate several hundred miles.

Work on all contracts is going forward as rapidly as practicable. In passing, it is pertinent to note that, from the beginning, out of about two dozen contracts let, but two have been abandoned by the contractors. The Commission hopes and expects that in the future, there will be no such failures on the part of contractors.

As previously explained, the several routes are subdivided by counties, and sub-subdivided into sections which are designated by letter.

The following shows the status of work on all sections to April 1st:

Route 1.

Marin. Secs. A and B. Surveys complete. Plans in progress.

Sonoma. Sec. B. Laid out as a state highway September 25, 1912. Contract awarded October 22, 1912, to Richard Keatinge & Sons. Length, 13.7 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $109,050. Probable cost per mile, $7,960. Per cent of contract complete March 15, 1913, 4.2 per cent. Secs. A and C surveys complete and plans in progress.

Mendocino. Sec. A. Laid out as a state highway May 21, 1912. Contract awarded July 23, 1912, to the General Contracting Corporation. Length, 12.8 miles. Road to be graded 18 feet wide but not paved. Probable total cost, $69,900. Probable cost per mile, $5,460. Per cent of contract complete March 15, 1913, 90 per cent. Sec. C. Laid out as a state highway February 4, 1913. Contract awarded March 26, 1913, to D. L. Sawyers and C. Whited. Length, 7.6 miles. Road to be water bound macadam and gravel 15 feet wide. Probable total cost, $55,665. Probable cost per mile, $7,325. Sec. E. Laid out as a state highway October 22, 1912. Contract awarded February 4, 1913, to Fairbanks & Baechtel. Length, 6.9 miles. Road to be graded 18 feet wide. Probable total cost, $32,845. Probable

cost per mile, $4,760. Secs. B, D, and F. Surveys and plans complete. Secs. I and J. Surveys complete and plans in progress. Secs. G, H, and K. Surveys nearly complete.

HUMBOLDT. Sec. A. Survey complete and plans in progress. Secs. B, C, D, E, F, and G. Surveys begun.

ROUTE 2.

SAN MATEO. Sec A. Survey complete. A1. Laid out as a state highway May 21, 1912. Contract awarded July 23, 1912, to F. R Ritchie & Co. Length, 5.4 miles. Sheet asphalt 24 feet wide on concrete base. Probable cost, $92,180. Probable cost per mile, $17,070. Per cent of contract completed to March 15, 1913, 66 per cent. A2. Laid out as a state highway October 22, 1912. Now advertised for contract. Length, 0.2 miles. Road to be asphaltic concrete on Portland cement concrete base 24 feet wide. A3. Laid out as a state highway March 26, 1913. Now advertised for contract. Length, 1.0 miles. Road to be asphaltic concrete on Portland cement concrete base 24 feet wide. Sec. B. Surveys and plans complete. B1. Laid out as a state highway October 22, 1912. Contract awarded March 26, 1913, to S. P. Doyle. Length, 3.3 miles. Road to be asphaltic concrete on macadam base 20 feet wide. Total probable cost, $42,980. Total cost per mile, $13,025. B2 Laid out as a state highway March 26, 1913. Now advertised for contract. Length, 1.8 miles. Road to be asphaltic concrete on macadam base 20 feet wide.

SANTA CLARA. Secs. A and B. Survey and plans complete. A1. Laid out as a state highway July 23, 1912. Contract awarded October 22, 1912, to City Street Improvement Company. Length, 6.4 miles. Road to be asphaltic concrete on macadam 20 feet wide. Probable total cost, $43,275. Probable cost per mile, $6,760. A2. Laid out as a state highway July 23, 1912. Contract awarded October 22, 1912, to A Teichert & Son. Length, 5.5 miles. Pavement, oiled concrete 20 feet wide. Probable total cost, $47,315. Probable cost per mile, $8,600. Per cent of contract completed to March 15, 1913, 57 7 per cent. B1. Laid out as a state highway October 22, 1912. Contract awarded March 26, 1913, to Richard Keatinge & Sons. Length, 13.0 miles. Pavement, oiled concrete 15

Motor Oil Spraying, State Highway, Los Angeles County.

feet wide. Probable total cost $87,865. Probable cost per mile, $6,760. B2. Laid out as a state highway March 26, 1912. Now advertised for contract. Length, 4.3 miles. Pavement, oiled concrete 15 and 20 feet wide. Sec. C. Survey complete and plans in progress.

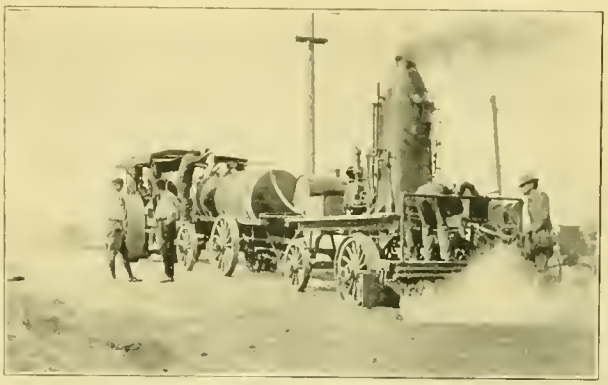
SAN BENITO. Survey complete.

MONTEREY. Secs. B and H. Surveys and plans complete. Sec. E. Laid out as a state highway October 22, 1912. Length, 7.3 miles. Pavement, oiled concrete 15 feet wide. Secs. C, D, F, G, and I. Surveys complete. Sec. A. Survey nearly complete.

SAN LUIS OBISPO. Secs. A, C, and D. Surveys and plans complete. D1. Laid out as a state highway October 22, 1912. Bid received and rejected November 18, 1912. Length, 6.4 miles. Pavement, oiled concrete 15 feet wide. Secs. B and E. Survey complete and plans in progress. Sec. F. Survey complete.

SANTA BARBARA. Secs. B and G. Surveys and plans complete. Secs. A and F. Surveys complete and plans in progress. Secs. C, D, and E. Surveys complete. Sec. H. Survey started.

VENTURA. Sec. A. Laid out as a state highway March 26, 1913. Now advertised for contract. Length, 7.3 miles. Pavement, oiled concrete 15 feet wide. Sec. F. Laid out at a state highway August 27, 1912. Length, 4.4 miles. This section includes a long timber trestle which was taken over by the State. Secs. B, C, D, E, and G. Sur-



Oiling Macadam near Madera.

veys complete and plans in progress. Secs. H and I (alternate route). Surveys complete.

LOS ANGELES. Sec. A. Laid out as a state highway September 25, 1912. Contract awarded October 22, 1912, to Rogers Bros. Co. Length, 6.6 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $50,090. Probable cost per mile, $7,590. Per cent of contract completed to March 15, 1913, 45.8 per cent. Sec. B. Laid out as a state highway February 4, 1913. Contract awarded March 4, 1913, to John D. Marsh. Length, 10.1 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $81,755. Probable cost per mile, $8,095. Sec. C. Survey and plans complete.

ORANGE. Secs. A, B, C, E, and F. Surveys complete and plans in progress. Sec. D. Survey complete.

SAN DIEGO. Sec. A. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to M. L. Curtis & Co. Length, 8.4 miles. Oiled concrete 15 feet wide. Probable total cost, $68,090. Probable cost per mile, $8,105. Per cent of contract completed to March 15, 1913, 54 per cent. Sec. B. Laid out as a state highway October 22, 1912. Bids received. No award. Length, 10.3 miles. Pavement, oiled concrete 15 feet wide. Secs. C and D. Surveys and plans complete.

ROUTE 3.

SACRAMENTO. Sec. A. Laid out as a state highway August 27, 1912. Contract awarded September 25, 1912, to Burns, Clark & Da Roza. Length, 1.8 miles. Oiled concrete 15 feet wide. Probable total cost, $13,320. Probable cost per mile, $7,400. Per cent of contract completed March 15, 1913, 93.8 per cent.

PLACER. Sec. A. Laid out as a state highway August 27, 1912. Contract awarded September 25, 1912, to Burns, Clark & Da Roza. Length, 9.9 miles. Pavement oiled concrete 15 feet wide. Probable

Spreading Screenings for Thin Bituminous Top, State Highway.

total cost, $83,820. Probable cost per mile, $8,465. Per cent of contract completed March 15, 1913, 25.0 per cent. Sec. B. Surveys complete and plans in progress.

YUBA. Sec. B. Laid out as a state highway May 21, 1912. Contract awarded July 23, 1912, to F. E. Frey. Length, 9.2 miles. Oiled macadam 15 feet wide. Probable total cost, $75,230. Probable cost per mile, $8,175. Per cent of contract completed March 15, 1913, 66.4 per cent. Sec. A. Survey complete and plans in progress.
SUTTER. Surveys and plans complete.

Motor Spraying Machine on State Highway, Los Angeles County.

BUTTE. Sec. D. Laid out as a state highway October 22, 1912. Bids received November 18, 1912 and rejected. Length, 11.2 miles. Pavement oiled concrete 15 feet wide. Secs. A, B, C. Surveys complete.
TEHAMA. Secs. A and C. Surveys and plans complete. Sec. B. Survey nearly complete.
SHASTA. Secs. B and D. Survey complete and plans in progress. Sec. A. Survey complete. Sec. C. Survey begun.
SISKIYOU. Sec. A. Survey complete and plans in progress. Secs. B and C. Surveys begun.

ROUTE 4.

SACRAMENTO. Built by the county.
SAN JOAQUIN. Built by the county.
STANISLAUS. Sec. A. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to E. O. Burge. Length, 12.1 miles. Oiled concrete 15 feet wide. Probable total cost, $84,850. Probable cost per mile, $7,010. Per cent of contract completed March 15, 1913, 55.9 per cent. Sec. B. Laid out as a state highway March 4, 1913. Contract awarded March 26, 1913, to Considine & Bates. Length, 9.6 miles. Pavement oiled concrete 15 feet wide. Probable total cost, $68,155. Probable cost per mile, $7,100.
MERCED. Sec. A. Laid out as a state highway October 22, 1912. Bids received. No award. Length, 14.2 miles. Pavement oiled concrete 15 feet wide. Sec. C. Laid out as a state highway August 27, 1912. Contract awarded September 29, 1912, to the Worswick Street Paving Company. Length, 10.9 miles. Oiled concrete 15 feet wide. Probable total cost, $84,805. Probable cost per mile, $7,780. Per cent of contract completed to March 15, 1913, 15.9 per cent. Sec. D. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to the Worswick Street Paving Company. Length, 9.6 miles. Oiled concrete 15 feet wide. Probable total cost, $74,775. Probable cost per mile, $7,790.
MADERA. Entire county under contract. Sec. A. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to the Worswick Street Paving Company. Length, 9.9 miles. Oiled concrete 15 feet wide. Probable total cost, $66,510. Probable cost per mile, $6,720. Sec. B. Laid out as a state highway May 21, 1912. Contract awarded July 23, 1912, to Ransome Crummey Company. Length, 9.9 miles. Oiled macadam 15 feet wide. Probable total cost, $74,255. Probable cost per mile, $7,500. Per cent of contract complete April 1, 1913, 53.3 per cent. Sec. C. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to Worswick Street Paving Company. Length, 6.8 miles. Oiled concrete 15 feet wide. Probable total cost, $46,100. Probable cost per mile, $6,780.
FRESNO. Sec. C. Laid out as a state highway July 23, 1912. Contract awarded August 27, 1912, to the Worswick Street Paving Company. Length, 9.6 miles. Oiled concrete 15 feet wide. Probable total cost, $62,615. Probable cost per mile, $6,520. Per cent of contract completed to March 15, 1913, 73.4 per cent. Secs. A and B. Surveys and plans complete.
TULARE. Secs. A, B, C, and E. Surveys complete and plans in progress.
KERN. Secs. C, D, E, and F. Surveys and plans complete. Secs. A and B. Surveys complete and plans in progress.
LOS ANGELES. Secs. A, B, C, and D. Surveys complete and plans in progress.

ROUTE 5.

SAN JOAQUIN. Built by the county.
ALAMEDA. Secs. A, B, C, and D. Surveys complete.
SANTA CLARA. Sec. A. Survey complete. Sec. B. Survey complete.
SANTA CRUZ. Sec. A. Survey complete and plans in progress.

ROUTE 6.

YOLO. Sec. A. Survey nearly complete and plans in progress.

ROUTE 7.

SOLANO. Secs. C and D. Surveys complete. Sec. E. Survey in progress. Secs. A and B. Surveys not begun.
YOLO. Sec. B. Surveys complete and plans in progress. Secs. A and C. Surveys complete.
COLUSA. Secs. A, B, and C. Surveys complete.
GLENN. Secs. A, B, and C. Surveys complete.
TEHAMA. Sec. A. Survey complete.

ROUTE 8.

Surveys not begun.

ROUTE 9.

LOS ANGELES. Sec. A. Survey complete. Sec. B. Survey in progress.
SAN BERNARDINO. Secs. A, B, C, and D. Surveys complete.

ROUTE 9A.

SAN BERNARDINO. Secs. A and B. Surveys complete and plans in progress.
RIVERSIDE. Sec. A. Survey complete and plans in progress.

ROUTE 10.

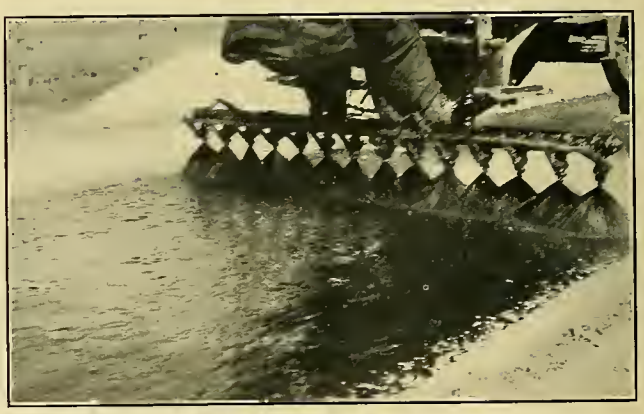
TULARE. Sec. A. Survey and plans complete.
KINGS. Sec. A. Survey and plans complete.

ROUTE 11.

SACRAMENTO. Sec. A. Survey complete and plans in progress.
EL DORADO. Secs. A and B. Surveys nearly complete.

ROUTE 12.

SAN DIEGO. Secs. A and B. Surveys complete. Secs. C, D, E, F, and G. Surveys in progress.



Spraying Asphaltic Oil on Concrete Base, State Highway, Los Angeles.

HOW BIG IS CALIFORNIA?

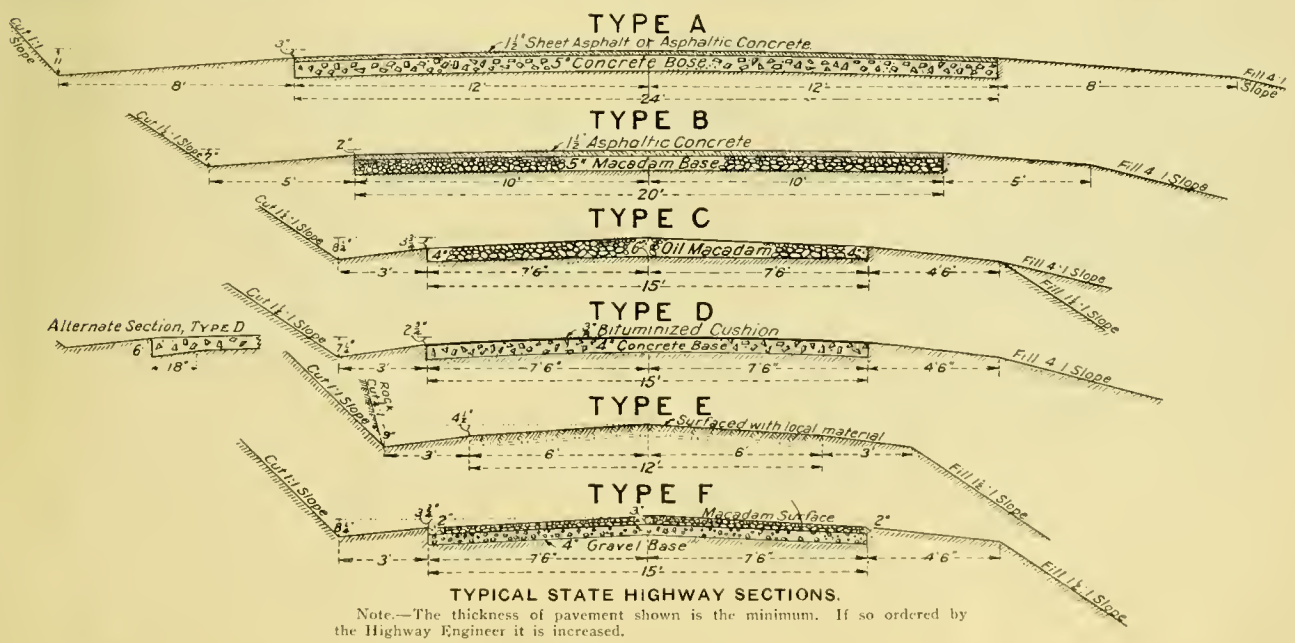
The area of this State is 158,360 square miles—an empire that exceeds by over one thousand miles the combined area of the following states: Massachusetts, 8,315; Delaware, 2,050; Maine, 33,040; New Jersey, 7,815; Connecticut, 4,990; Rhode Island, 1,250; New York, 49,170; Vermont, 9,565; Ohio, 41,060 square miles.

The total area of the United Kingdom, England, Scotland, Ireland and Wales is 121,391 square miles. Add to their territory the areas of Maine, Delaware and Rhode Island, and you are still short of the total area of California by 600 square miles.

It is the office of the California Highway Commission to conserve the state highway fund of $18,000,000 and apply it justly and equitably under the law for the good of this giant commonwealth. In the language of Governor Johnson, "It is arbitrary and unjust to build roads in some of the counties and leave others unserved."

Table of Layouts, Showing Mileages, Types of Roads, Probable Costs, and Names of Contractors

Layout.	Contract	Division.	County.	Route.	Section.	Miles.	Total probable cost exclusive of engineering and overhead.	Type of pavement	Contractor. Corrected to May 1, 1912.
1	1	IV	San Mateo	2	A1	5.4	$92,177	21 feet sheet asphalt on Portland cement, concrete base.	F. R. Ritchie.
2	2	I	Mendocino	1	A	13.2	69,886	18 feet graded	General Contracting Corp.
3	3	VI	Madera	4	B	9.9	74,254	15 feet oil macadam	Ransome-Crummey Co.
4	4	III	Yuba	3	B	8.9	69,928	15 feet oil macadam	F. E. Frey.
5	5	III	Stanislaus	4	A	11.1	77,892	15 feet oiled concrete	E. O. Burge.
6	6	VI	Merced	4	D	9.6	74,777	15 feet oiled concrete	Worswick Street Paving Co.
7	7	VII	San Diego	2	A	8.4	68,091	15 feet oiled concrete	M. L. Curtis & Co.
8	14	IV	Santa Clara	2	A1	6.4	43,274	20 feet asphaltic concrete on macadam base.	City Street Improvement Co.
------	15	IV	Santa Clara	2	A2	5.5	47,338	20 feet oiled concrete	A. Teichert & Son.
9	8	VI	Fresno	4	C	9.6	62,616	15 feet oiled concrete	Worswick Street Paving Co.
10	9	VI	Madera	4	A	9.9	66,512	15 feet oiled concrete	Worswick Street Paving Co.
11	10	VI	Madera	4	C	6.8	46,100	15 feet oiled concrete	Worswick Street Paving Co.
12	11	VI	Merced	4	C	10.9	84,711	15 feet oiled concrete	Worswick Street Paving Co.
13	--------	VII	Ventura	2	F	4.4	----------		
14	12	III	Sacramento	3	A	1.8	13,277	15 feet oiled concrete	Burns, Clark & DaRoza.
15	13	III	Placerville	3	A	9.9	83,600	15 feet oiled concrete	Burns, Clark & DaRoza.
16	16	IV	Sonoma	1	B	13.7	108,761	15 feet oiled concrete	Rich. Keatinge & Sons.
17	17	VII	Los Angeles	2	A	6.6	49,928	15 feet oiled concrete	Rogers Bros. Co.
18	--------	VI	Merced	4	A	14.2	----------	15 feet oiled concrete	E. O. Burge.
19	5 Ex.	III	Stanislaus	4	A	0.7	4,907	15 feet oiled concrete.	
20	--------	III	Butte	3	D	11.2	----------	15 feet oiled concrete.	
21	29	IV	San Mateo	2	A2	0.2	4,825	24 feet asphaltic concrete on Portland cement, concrete base.	Clark and Henery Const. Co.
22	22	IV	San Mateo	2	B1	3.3	42,980	20 feet asphaltic concrete on macadam base.	S. P. Doyle.
23	23	IV	Santa Clara	2	B1	13.0	87,863	15 feet oiled concrete	Rich. Keatinge & Sons.
24	--------	V	San Luis Obispo	2	D	6.4	----------	15 feet oiled concrete.	
25	--------	V	Monterey	2	E	7.3	----------	15 feet oiled concrete.	
26	--------	VII	San Diego	2	B	10.4	----------	15 feet oiled concrete.	
27	20	I	Mendocino	1	E	6.9	52,911	18 feet graded	Fairbanks & Baechtel.
28	24	I	Mendocino	1	C	7.6	55,651	15 ft. water-bound macadam, gravel	D. L. Sawyers and C. Whited.
29	21	VII	Los Angeles	2	B	10.1	81,690	15 feet oiled concrete	John D. Marsh.
30	25	III	Stanislaus	4	B	9.6	68,154	15 feet oiled concrete	Considine & Bates.
31	5 Ex.	III	Stanislaus	4	A	0.3	2,049	15 feet oiled concrete	E. O. Burge.
32	4 Ex.	III	Yuba	3	B	0.3	5,302	15 feet oiled macadam	F. E. Frey.
33	26	IV	San Mateo	2	A3	1.0	20,415	24 feet asphaltic concrete on Portland cement concrete base.	Flinn and Treacy.
34	27	IV	San Mateo	2	B2	1.8	20,215	20 feet asphaltic concrete on macadam base.	Raiseb Improvement Co.
35	28	IV	Santa Clara	2	B2	4.3	34,235	15 feet / 20 feet oiled concrete	Richard Keatinge & Sons.
36	--------	VII	Ventura	2	A	7.3	----------	15 feet oiled concrete.	
37	--------	IV	Santa Clara	2	A3	1.2	----------	20 feet oiled concrete.	
38	--------	VII	Los Angeles	2	C	11.3	----------	15 feet oiled concrete.	



TYPICAL STATE HIGHWAY SECTIONS.

Note.—The thickness of pavement shown is the minimum. If so ordered by the Highway Engineer it is increased.

THE MAINTENANCE PROBLEM

(Written for this Bulletin by President Benjamin Ide Wheeler, University of California)

In planning a system of roads I should say the first thing was to plan for keeping those roads in repair. It is no great trick to build roads. The great anxiety must concern their upkeep. I do not see that this has been heretofore in California very much considered. It is pitiful to see the miles of roadway which are going steadily and rapidly into decadence. A fine macadamized road that is degenerating into ripples and bogs is a lure and a deceit. Now is the time to think out the problems connected with road repair. We are planning to open hundreds of miles of road. The initial expense is very slight as compared with the capitalized cost of annual upkeep and repair. It is useless to say that the roads will be so thoroughly constructed that repair will be inconsiderable. We

Ready for Concrete, State Highway, near Fresno.

know that that is not so. The excellent roads of France, Germany and England—and those of England now are the best—are maintained by patient, consistent, and continuous work at repairing. Whenever a slight depression shows itself on the surface of a road—a depression sufficient to accumulate moisture—it is immediately attacked and cut out like the beginnings of a cancer. One can not afford to wait; such a rotten spot grows with its own growth and then with the natural rebound of the vehicle starts other like rotten spots agrowing. It is useless to think of treating these cases by sweeping mechanical means. It is work that must be done in detail and by hand. Heretofore we have viewed the task only in its grosser forms because we have waited for the trouble to become serious before we have attacked it. If we are to have really good highways our work of repair must become much more minute than heretofore. I close where I began. The problem of road building is a problem of repairing.

THE COUNTIES WILL BUILD THEM

Probably every proposed route for the state highway that has been urged upon the Commission is a needed public thoroughfare, and if not now open and improved will in no distant day be constructed.

As to those three or four routes which have been made the subject of the greatest contention, it is a matter of common knowledge in the various localities where these proposed routes are located that their construction has practically already been determined upon by the interested counties themselves, in the event they are not adopted by the Highway Commission.

It may, therefore, be expected that in the near future, possibly before the state highway itself is completed through these particular districts, that these roads, such as the so-called Riverside-Watsonville, the Hanford-Visalia-Porterville and the Tehachapi routes will be in course of construction. So be it.

Madera's State Highway

Madera Tribune, April 10, 1913.

The work on the state highway is progressing with great rapidity, and the work being done insures a good and lasting road. The crew has crossed the river and has commenced the work of grading the hill on this side. The road from Herndon in to Fresno is a perfect drive, and that will be the condition of the great highway when completed.

PROGRESSIVE CALIFORNIA COUNTIES

Many counties are moving in the matter of systematically and permanently improving their local highway systems and joining them to the State's trunk roads.

The following counties in the amounts mentioned contemplate voting bonds for this purpose as soon as practicable: San Bernardino, $1,500,000; Fresno, $2,000,000; Tulare, $1,500,000; Santa Cruz, $1,000,000; Kern, $2,500,000; Sacramento, $2,000,000; Humboldt, $1,300,000; Nevada, $350,000; Solano, $1,000,000; Madera, $600,000; Trinity, $100,000; Riverside, $1,500,000.

These amounts in the aggregate exceed $15,000,000.

Orange County recently voted bonds in the sum of $1,270,000 and as elsewhere stated San Mateo County has incurred an indebtedness of $1,250,000 for the same purpose.

Similar movements are in progress in Santa Barbara, Ventura, Merced, Marin and Sonoma counties.

A Beautiful Boulevard

Ukiah Democrat, April 4, 1913.

Hopland, April 3.—A large road roller arrived for the Highway Commission Wednesday to be used in putting the new road in condition between here and Sonoma County. This roller is one of the latest improved self propelling type, power being furnished by a gasoline motor. The weight of the machine is thirteen tons equipped for the road. The new road soon to be completed by the State is a splendid piece of work. Might properly be called a boulevard, rising gradually out of Sanel Valley until it commands a beautiful view of the picturesque country surrounding, with Russian River nearly always in sight; and the best part of it is, one does not need to keep the eye continually on the road ahead to avoid striking ruts, bumps or running into the bank.

Sausalito Shows the Way

April 14th, Sausalito, by a vote of 658 to 177, voted for municipal bonds in the sum of $100,000, for the purposes of building an asphalt pavement, beginning at the Fort Baker Reservation, around the water front, via the ferry to the northern limits of the town, connecting there with the state highway. The event was celebrated with bonfires, bells, horns, parades and oratory.

"A wave of civic pride," as the press dispatches describe it, was started by this successful campaign for the good road cause.

Other cities in Marin County, Corte Madera, Larkspur, Ross, San

Placing Concrete Base, State Highway, Los Angeles County.

Anselmo, San Rafael, and Novato, are all possessed of the same spirit of enthusiasm over the prospects of the building of the state highway in Marin County, as surveyed by this Commission.

Fiscal Agency Too Long Delayed

State Treasurer Roberts is of the opinion that the establishment of a fiscal agency by the State in the east has been too long delayed; and he confidently expects, unless the money market goes from bad to worse, to be able to float large blocks of harbor and highway bonds through the medium of the State's proposed New York fiscal agency.

STORY OF THE REBUILDING OF HISTORIC EL CAMINO REAL

Modern Road Making Methods Graphically Described by the Engineer in Charge

By A. E. Loder, Division Engineer, Division No. IV

El Camino Real of the Padres, traversing the picturesque coast of California from San Francisco to Los Angeles and beyond to San Diego, will for the most part be rejuvenated and transformed (except in name) into Route 2 of the state highways system and should become one of the most interesting and frequented lines of travel for visitors to the Golden State during 1915. This highway connects with Mission street of the Exposition City and passes through the counties of San Mateo and Santa Clara, where it bears the historic names of the Mission Road and the Monterey Road.

Beginning of the Work.

The first work of construction on this route was begun near its northerly terminus in San Mateo County on the section lying between South

Raking Asphalt Surface, State Highway, San Mateo County.

San Francisco and Burlingame. In San Mateo and Santa Clara counties four additional contracts are now under way, four others have been awarded, and one is being advertised. According to present plans, this highway should be completely paved from San Francisco to Sargent at the southerly extremity of Santa Clara County by the end of 1913.

The contractor in charge of this first stretch of construction began the work late last season. Many embarrassing delays ensued, due to the financial troubles of the contractor and to his lack of system, and the surety company on his contract was compelled, upon the demand of the Commission, to take over the work and place it in the hands of a second contracting firm. The work is now progressing as satisfactorily as the weather permits.

Type of Construction.

The type of construction on this first contract and some of its features which are not in common use in the construction of interurban roads, may be of interest.

The roadway is graded to a width of 40 feet, with a maximum gradient of 4 per cent, conforming with the rolling contour of the country. Long, easy, vertical curves connect all changes of grade, producing a pleasing profile. Flat curves are used at every deflection in the line.

The pavement is 24 feet in width and has a crown of 4 inches. Earth shoulders containing gravel and old macadam extend to a width of 8 feet along each side of the pavement with a cross slope of 1¼ inches per foot.

The pavement rests upon a thoroughly compacted sub-grade composed of old macadam and a sand-clay mixture resembling hardpan, which after rolling is in such condition that it is not damaged when the gravel and sand are hauled and dumped directly upon it without the use of planking, and it remains so compact that no dirt is picked up with the sand when loading it into the mixer.

Timber headers 2 inches by 6 inches, nailed to stakes, line the pavement trench and are laid to a line flush with the finished surface. These protect the edges of the pavement while the shoulders are being settled by traffic, and provide a means by which the pavement may be readily brought to a true and uniform surface.

The pavement consists of a 5-inch concrete base composed of a 1 : 3 : 6 mixture, to which is bonded a standard sheet asphalt surface one inch in thickness.

How the Concrete is Mixed.

The concrete is prepared in a portable mixer to a rather wet consistency and is delivered directly to its place in the pavement by means of a swinging spout. The laitance or silt-like film which forms on the surface of the concrete, not being so strong in texture as the concrete itself, would probably weaken any bond with surfacing material placed over it. To remedy this, the surface is given a rough finish, suitable for binding bituminous material, by sweeping across the line of pavement with a stiff house broom or warehouse broom before the concrete reaches its final set. The new concrete is watered daily, except in rainy or damp, cloudy weather, until about five days old.

The asphalt wearing surface being laid on this job is shown on the daily test sheets to be as near the standard grading and composition as is possible to obtain. Nothing unusual is noted in connection with its use, except that a greater density is obtained after rolling the one-inch sheet than is possible with a thicker city surface, and consequently better wearing qualities and more stability should be expected.

The most unusual features of this construction are the thin asphaltic coat used as a binder and the asphalt surface which is thinner than that usually laid upon city work.

Asphalt Surfaces in Cities.

City street asphalt surfaces are usually laid from 1½ to 2 inches thick, with an intermediate binder course of broken stone held together with asphaltic cement and more or less sand. However, the records of several leading cities throughout the country show that in years past, as well as at the present time, standard sheet asphalt as thin as 1½ inches has been laid without a binder, the results being satisfactory wherever a reasonably well graded asphalt was used.

An asphalt pavement of the usual standard city construction, or an asphalt concrete pavement, would be much to be desired on interurban or country highways if its expense could be provided for. In the present case economy and shortage of available funds demanded that a cheaper form of construction be used, while at the same time the traffic conditions called for a pavement substantially as durable as the more expensive types. This resulted in the character of road described, which, so far as completed and tested, promises to give satisfaction.

Applying the Paint Binder.

When the concrete is dry and at least one week old, it is thoroughly swept, removing the dust of traffic passing at the side of road. The

Rolling Asphalt Surface, State Highway, San Mateo County, Near Lomita Park.

binder coat above mentioned is then applied. This coat consists of one part by volume of melted asphaltic cement, of the consistency used in the pavement, to two parts by volume of engine distillate. The asphaltic cement is heated in a small portable kettle to a temperature between 200 and 325 degrees. A measured quantity is removed to the spreading

pail a safe distance from the fire and allowed to cool to about 250 degrees. The distillate is then added and stirred for about one minute, when it is found to be thoroughly uniform and the temperature is reduced by at least 100 degrees. The distillate can be added when the asphalt is at a temperature of 325 degrees, but at this temperature it is accompanied by considerable boiling and is somewhat dangerous.

Poured Hot from Buckets.

The binder liquor, while hot, is poured over the concrete from buckets, and uniformly swept over the surface with stiff house brooms until

Spreading Asphalt Paint Coat, State Highway, San Mateo County.

every particle of surface is coated with a thin film and all excess is swept from holes or depressions in the concrete. The paint binder penetrates deeper into the concrete when permitted to flow in a thin wave ahead of the first sweeping. A second sweeping after a few minutes removes excess from depressions and spreads it uniformly over the concrete. The thinnest possible application of paint should be used so that after evaporation, which is complete in from one and one half to two hours, the surface should have a glossy black appearance. If too small a quantity is used, or if the percentage of asphaltic cement to distillate is considerably less than above, a brown surface will result, which will not make a successful bond with the asphalt surface.

Cost of Applying the Binder.

Two men can easily mix and apply this asphaltic coat on 12,000 square feet per day. On 69,000 square feet, where the proportions were being varied somewhat, it was found that 100 square feet required 0.856 gallon of engine distillate and 3.5 pounds of asphaltic cement. The total cost on above area, including 15 per cent on labor, was $0.0018 per square foot of surface. The economy in using this type of binder is apparent when it is considered that the old style of binder used on city work costs from 3 to 4 cents per square foot while the paint binder costs less than one fourth cent per square foot.

It is found that no inconvenience is caused to the work of laying asphalt by the placing of the asphaltic coat. After one hour's time it does not stick to the wheels of motor trucks or wagons. It is not desirable to so cover the concrete farther ahead of the asphalt work than is required for the distillate to evaporate and leave the binder hard.

Effect of Rains on Exposed Paint Binder.

In one case, several days' rain which fell on paint freshly applied caused the asphaltic coat to appear loosened from the concrete in many places. After two days' dry weather, however, it seemed to bond again to the concrete so that it could not be removed. It is believed that the paint binder will tend to waterproof the asphalt surface, preventing damage to its under side from moisture which may rise through the concrete.

If the asphaltic coat is allowed to accumulate in any quantity in a depression such as a heel mark, its location is soon apparent after the placing of asphalt since excess asphaltic cement appears on the surface during rolling. With reasonable sweeping, however, no trouble of this kind has been experienced.

There is a marked difference in the behavior of hot asphaltic mixture under the roller where the paint binder has been used and where it has been omitted. Where concrete has been painted, the asphalt does not move or welt up in front of the roller to any appreciable extent, as is noted when rolling asphalt on plain concrete.

It is found that the asphaltic cement, while dissolved in the distillate, penetrates into the surface of the concrete to a distance of from one tenth to one eighth of an inch, and in some cases even further. Samples of the surface removed show the concrete adhering uniformly to the asphaltic surface. When removing the sample the concrete is fractured and a layer of solid concrete is removed carrying the first layer of finer gravel. When trimming a joint to begin a new day's work, the surface of the concrete base is always broken off in removing the thin edge of asphalt which has been cut from the finished work.

An Experimental Demonstration.

For experimental purposes, a few hundred feet of the surface has been placed without the use of the paint binder. As expected, no bond is secured except that of a mechanical nature, due to the roughness of the concrete. Notwithstanding the surface remains in first class condition after one month of heavy traffic, and it is believed that good results will be obtained under wear without the use of a binder of any kind. However the use of this binder at so small an additional cost will improve the pavement and prolong its life to such an extent that it will more than justify its expense.

While the asphaltic binder is not altogether a new idea, it is a new method on highway work. The history of its use elsewhere indicates that no injurious results are to be expected and that it offers a means whereby a wearing surface may be securely bonded to concrete with less thickness of asphalt and consequently less expense than beretofore, especially on work which is not called upon to meet city traffic conditions. The low cost of applying the coat, even on a small scale, also shows that it is available as a cheap and sure method of bonding a very thin mastic wearing surface to a concrete roadway.

The Glenn County Stony Creek Bridge

The bridge to be constructed over Stony Creek, near Orland, in Glenn County, on the route of the state highway, will be one of the largest concrete highway bridges in the United States. The plans and specifications for this bridge were adopted as the result of a competitive examination, and were prepared by Daniel Luten.

These plans provide for a structure twelve hundred feet long composed of thirteen monolithic concrete arches, varying in length of span from seventy to one hundred feet. It will have a twenty-four foot clear roadway composed of a concrete base with a two-inch asphalt wearing surface.

The concrete foundations are carried, approximately, twenty-five feet below the bed of the stream, at which depth thirty foot piles will be driven as a further support. The bridge is designed to carry a uniform load of one hundred and fifty pounds per square foot over the entire floor surface, and a concentrated load of a twenty-four ton road roller. However, the bridge, considering the factor of safety, is designed to carry four times these loads.

It is to be built well above high water, but the designer states that in case of a flood it would stand the test of being entirely submerged. Mr.

Finished State Highway, Lomita Park, San Mateo County.

Luten states that over two thousand concrete bridges of the same design were in the recent Ohio and Indiana floods, and although three thousand bridges were destroyed, not a bridge of this type was seriously injured.

While strength and permanence are essential features in the design of the Stony Creek bridge, the artistic elements are not forgotten. The long, graceful curves of the arches will be surmounted by an ornamental concrete railing in harmony with the balance of the structure.

It is estimated that this structure complete will cost $145,000. Construction work will begin in May, 1913, and it is expected that the bridge will be ready for traffic by December of this year. The Ross Construction Company of Sacramento prepared the plans.

SECURING RIGHTS OF WAY FOR THE STATE ROADS

County Boards of Supervisors Give Effective Assistance, and Land Owners are Generally Liberal

By C. C. Carleton, Attorney

The Attorney General of the State is the chief legal adviser of the Commission.

Hon. U. S. Webb, present incumbent, was Attorney General of California at the time the measure was prepared providing for the issuance of $18,000,000 of bonds, for the acquisition, construction, and maintenance of a system of state highways, and the people of the State are greatly indebted to him for his care in putting the bill in proper legal form.

Since the adoption of the "State Highways Act" by the people at the general election of 1910, the Attorney General has rendered many important opinions relating to the proper conduct of the work of acquiring and constructing the state highway system, and such opinions have been the guides for the officers entrusted by law with the duty of accomplishing the purposes of the bonding act.

An Ocean View from State Highway near Arroyo Honda, Santa Barbara County.

The Attorney General and his assistants have greatly facilitated the work of the Commission by prompt and able attention to all matters submitted to them.

Attorney.

Among the technical assistants deemed necessary by the Commission was an attorney qualified by experience in highway law who should devote his entire time to routine matters of a legal nature continually arising during the progress of the highway work, and who should direct all right of way activities.

Consequently, the approval of the Governor and the Attorney General first having been obtained, an attorney, who had been engaged in a similar capacity by a county highway commission, was chosen attorney of the commission, and since November, 1911, has given all of his time to the performance of his duties.

All forms of contracts, bonds, leases, deeds, resolutions, and other legal writings of the Commission are prepared in this department. The legal sufficiency of contracts, conveyances of rights of way, and titles to highways and lands, is determined. The principal function of the legal department, however, is the acquisition of necessary rights of way in a legal and orderly manner.

Rights of Way.

Ordinarily, in the forwarding of "good roads movements," the promoters do not consider the seriousness of the right of way problems. Too often the public spiritedness of all land owners is taken for granted, and when money is provided and actual work commenced, it is discovered that land owners do not intend to donate necessary rights of way, but demand fancy figures for the realty affected. The Commission, however, has from the beginning realized the importance of acquiring rights of way promptly and systematically.

The counties of the State, acting through their boards of supervisors, have almost unanimously promised to provide free rights of way for the state highway system, realizing that their officials and citizens can acquire the necessary rights of way easily and inexpensively.

The Commission, as a rule, withholds the adoption of a layout until the right of way has been acquired by the county authorities. Local influence usually induces recalcitrant or indifferent land owners to come to terms.

It is confidently anticipated that this method of handling rights of way by the counties will result in the saving of tens of thousands of dollars to the taxpayers of the State.

The land owners in all sections, as a general rule, have been very generous and public spirited in donating the rights of way requested from them by the county representatives. A belligerent or unreasonable land owner soon discovers himself very unpopular in his own community. The money compensation thus far paid by the counties for rights of way has been an almost negligible sum compared with the amount of land acquired. As yet very few condemnation proceedings have been necessary. But the acquisition of rights of way is a slow matter even when the land owners are liberally inclined. A vast amount of work must be done. Records must be searched to ascertain the record owners of the land affected; owners must be interviewed or corresponded with; sketches and maps must be furnished to many owners delineating the rights of way desired; minor adjustments of lines and fences must be settled; vacation proceedings arranged and prepared abandoning the old roads or portions of road over property so as to leave no incumbrance on the same when the new road is located and built; co-owners must consult among themselves before executing the deeds of easement; ownerships involved in probate proceedings or title litigation must be searched and a good title to the new highways acquired out of the confusion.

The attorney of the Commission since entering upon the discharge of his duties has investigated and reported upon land and highway titles in all portions of the State, attended meetings of boards of supervisors in many counties to discuss ways and means for the prompt acquisition of rights of way, and supervised all the right of way activities of the state and county officers and employees.

In conclusion, it may be stated that the rapidity with which the state highways are laid out and completed will very greatly depend upon the attitude assumed by property holders, and it is to be hoped that all owners will truly appreciate the value of the proposed state highways to their lands and communities, and will be ready and willing to donate the easements solicited, and thereby materially contribute toward the ultimate success of the state highway work in California.

Saving the Trees, State Highway near Roseville, Placer County.

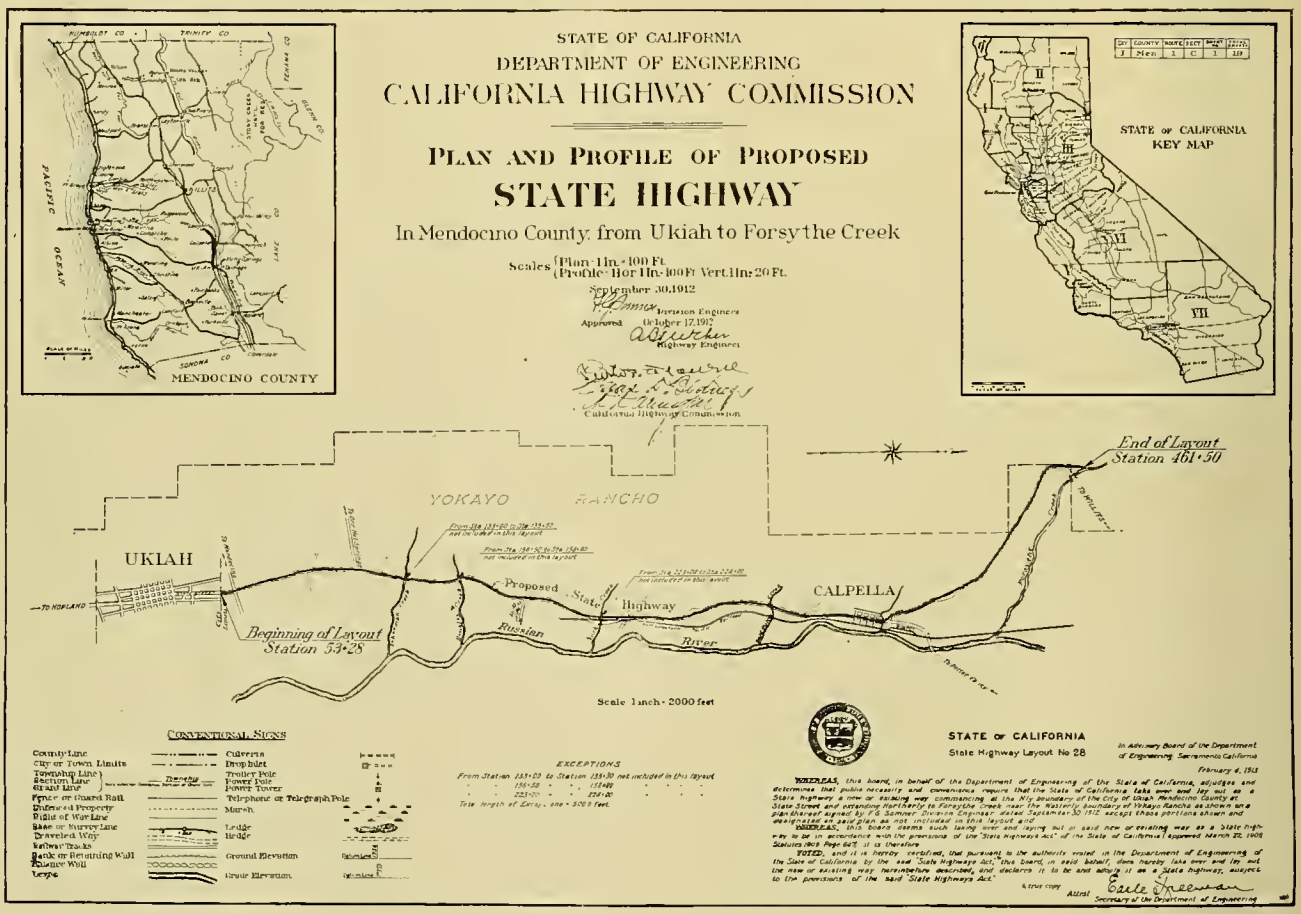
Roller Skating on the State Highway

Press dispatches report that "skating rinks in San Mateo County are doomed to a natural death, judging from the avidity with which the young folk of the peninsula towns have taken up the fad of utilizing the new state highway for roller recreation. Moonlight skating parties are quite the common thing on the new smooth surface of El Camino Real. A party of young people from South San Francisco skated six miles to Easton one evening, built a big bonfire and served coffee and cake."

Plotting the Plans and Profiles for Layouts for the State Highway

The plan is plotted from left to right, to a scale of 100 feet = 1 inch, the base line being laid by latitude and departure as obtained from the field traverse notes. Only the base line and the data relating thereto are inked. The profile is plotted below the plan and to scales of 100 feet = 1 inch horizontally and 20 feet = 1 inch vertically. The cross-sections are plotted to a scale of 5 feet = 1 inch, generally in two columns running up the sheet. After the alignment and grade have been tentatively fixed on the plan and profile, and have been transferred to the cross-sections by means of celluloid templets, the cut and fill areas on the cross-sections are measured with a planimeter and converted into cubic yards. The grade is then altered as may be necessary to give a proper balance of quantities in each one thousand feet of road.

The layout plans are made on sheets of tracing cloth twenty inches wide and thirty inches long, a binding margin being retained on the left The first sheet of each set carries the title, a finder map of the State and one of the county, a small scale plan of the entire road, a table of conventional signs, and a certificate of layout. The last sheet is a sheet of standard structures and typical sections, and the intermediate sheets are of plan and profile, one half mile per sheet, traced from the brown paper plan. In order to maintain a uniform appearance, "zinco" engravings have been made of so much of the title and structure sheets as is common to all plans, and the sheets are printed from them. The balance, which must be done by hand, is filled in in the headquarters drafting room. Following is a typical title sheet of these plans:



San Joaquin County's Traffic Census

In its report for the period from July 1, 1912, to January 1, 1913, the Highway Maintenance Department of San Joaquin County shows some interesting data on the volume of traffic over the newly improved roads of that county.

The tabulation shows that the daily averages per observer's station were as follows:

		Per cent.	Per cent.
Horsedrawn:			
Light vehicles	87.7	36.0	
Heavy vehicles	44.2	18.2	
Total horse drawn	131.9		54.2
Motors:			
Runabouts	19.5	8.0	
Touring cars	66.9	27.5	
Motor cycles	23.5	9.7	
Motor trucks	1.5	0.6	
Total motors	111.4		45.8
Total all kinds	243.3		100.0

The traffic census was taken for a period of seven days from August 26, 1912, to September 1, 1912, inclusive, and on each day the count of vehicles began at seven o'clock in the morning and lasted until seven in the evening. All vehicles, except bicycles, were counted.

In the tabulation "light vehicle" means a buggy, cart, buckboard, carryall, spring wagon or any vehicle other than a motor drawn vehicle, which is usually driven for pleasure or light business purposes. By "heavy vehicle" is meant a farm, milk, hay or grain or truck wagon, dray, grocery wagon, or any other vehicle, except a motor vehicle, usually carrying heavy loads.

The report states: "With this large amount of motor drawn vehicles passing over our highways, it would be impossible to maintain the same to any degree of efficiency were it not for the fact that the majority of all of these roads have all been constructed of oil macadam, or asphalt macadam with the bituminized wearing surface. The effect of the automobiles on this wearing surface has been beneficial, rather than detrimental, except in cases where the vehicles travel at so great a rate of speed that in turning out, the edges of the pavement are ruined. The action of the automobile tires upon the bituminized wearing surface has not been injurious to the pavement.

CALIFORNIA HIGHWAY BULLETIN

PUBLISHED BY THE CALIFORNIA HIGHWAY COMMISSION

DEPARTMENT OF ENGINEERING, STATE OF CALIFORNIA

VOLUME II | JULY 1, 1914 | NUMBER 1

CALIFORNIA STATE HIGHWAY SOUTH OF SAN FRANCISCO

CALIFORNIA STATE PRINTING OFFICE, SACRAMENTO

California Highway Bulletin

CALIFORNIA HIGHWAY COMMISSION
FORUM BUILDING, SACRAMENTO

CHARLES D. BLANEY, Chairman; N. D. DARLINGTON, C. F. STERN, Members. A. B. FLETCHER, Highway Engineer. C. C. CARLETON, Acting Secretary and Attorney

JULY 1, 1914

Published quarterly by the California Highway Commission for free distribution
GEORGE B. HARRISON, Editor, 511 Rialto Building, San Francisco

Maintenance

To construct, then to maintain—divide that motto when modern highway building is planned, and it would be as well to wipe out the slate entirely. Construction and maintenance must both be considered, and construction without adequate maintenance plans is in great part a loss of the money expended. Traffic is more exacting and less patient than it was a few years ago, and there is more of it and it insists on going farther. All that means wear and tear, which makes it impossible to stop merely with the building, for nowadays no road can be built that is self-preserving.

Bonds issued to provide funds for a permanent road should not be drawing interest after the expiration of the road itself, but that very situation has occurred in America. Perhaps the first thing in road building to-day is the long look ahead. That is peculiarly the case in the West, where development is so promising, and, too, where the traveling instinct which impelled the settler remains with him. The road engineer to-day has human problems of equal importance with engineering problems; he must ask himself what will be the probable travel of a decade or two in the future, and he must consider how to conserve this year's expenditure so that it may be in the useful class for a long time to come.

A road is like a horse or automobile in that it will last longer if treated rationally and looked after regularly; that costs money, but it costs considerably less than to go out and buy an entirely new road. Maintenance must be vigilance, and it is largely the ounce of prevention.

Construction and maintenance are dovetailed in the plans of the California Highway Commission, so that the road is built to the best advantage and maintained as nearly as possible to the condition at the time of completion. Taking into consideration the fact that the eighteen millions are by no means the end of California's expenditure for highways, the present State Highway is planned so that it may be widened, or otherwise improved, through later appropriations without tearing out and losing the present expenditures. Mileage of the permanent form of construction is lengthened by planning improvement along with maintenance.

The maintenance crews will be kept busy and on a permanent lineup by supplementing their repair work in widening the roads. It is not desirable that a maintenance employee should be idle part of the time, nor is it economy to pick up men now and then as maintenance may make their employment possible. Hence the maintenance crews will be more efficient and profitable to the State by being trained to the work and employed permanently through the addition of tasks that will keep them on full time. They will make the needed repairs and will meet emergencies at once, and will also improve the roads by building the hardened rock shoulders on either side of the pavement. This will widen the road of minimum width, fifteen feet to twenty-one feet, will protect the edges of the pavement and will give room for passing and turning. In that way it will be possible to keep up the standard of maintenance without losing the full day's work of the crews in addition to extending the constructing power of the original highway fund.

When the first contracts were started it was not economical to employ a high class road engineer to check the local work, but as soon as the number of contracts justified the expenditure the California Highway Commission secured an expert trouble finder—a high type of road engineer who is constantly on the road, inspecting one contract after another and checking on all phases of the work. He gives the resident engineers and others an exchange of practical experience materially affecting the value of their work, and checks closely on all phases of the construction.

The State Highway is homemade so far as materials go. California cement and California asphaltic oils are utilized.

"Safety First"

California's State Highway is laid out much as a railroad is planned. It provides for new ideas in traffic, for the 200-mile day of the individual traveler, for the motor truck train, and for access to and through sections where the varied topography of this State means a jump from sea-level to snow-level in a day's tour.

As with a railroad, safety is given consideration not thought of in ordinary road building. Grades are eliminated as much as possible, crossings of railroads at grade are abolished when that can be done, curves are made more sweeping and less blind, and mountain roads are protected and made over, so that touring in California will be a delight, never a menace, no matter what section of the State Highway may be traversed by motorists.

When one considers that the automobile traveler will be able to enter the State from Oregon, surmount that old barrier of Bailey's Hill, pass Mount Shasta on the north, and leaving the Great Valley in the south, take a panoramic road over the mountains into Los Angeles and roll into San Diego without having shifted gears once from Oregon to Mexico so far as grades are concerned—when one mentally reviews the old road and compares with the new the safety feature of the State Highway, the economical feature and the feature of "city streets in country places" all become apparent as contributions to the luxury of "seeing California."

Protecting the Highway

In some sections of California the necessity for cooperation in maintaining the State Highway is not appreciated by every user of the roads. Disc harrows, traction engines and other implements not built for travel on an improved highway or a paved road have been driven wantonly along the concrete road in spite of warnings and requests of representatives of the California Highway Commission.

A damage of more than one thousand dollars may be inflicted in a few minutes, and a totally unnecessary damage as well, even from the viewpoint of a man who may care nothing at all for highway improvement. Instances have been reported of traction engines taking the highway and causing damage where the engine might have been run as easily by the side of the road. In one case, near Los Angeles, a harrow or other implement which cut a sharp line into the pavement turned off the road entirely to pass a vehicle and was driven back again, showing that the driver might have avoided the damage if he had possessed any patriotic regard for good roads.

While the State Highway is new, education may be necessary to arouse a proper regard for its maintenance. Users of the highway who witness palpable damage being inflicted should exercise their prerogative as citizens, and at least remonstrate with ignorant or vicious destructionists. Instances of damage are being followed up promptly by the Highway Commission, and, when wilful, prosecutions will be instituted.

The Highway Bulletin

The Highway Bulletin is published by the California Highway Commission as a report to The People on progress in construction of the State Highway. It is issued quarterly, and is for free distribution. Constant requests come for information about the State Highway, and most of these are answered by the articles presented in the Highway Bulletin.

Day labor is utilized on the State Highway only when the contract system fails through inability to obtain contractors under the requirements of the law, or if a failure of the contractor compels the State to complete the work. It is regarded by the Highway Engineer as a policy to be followed only when essential to substitute it for the letting of contracts.

Traveling men in California are now making up parties and taking automobiles to go from one city to another, making a saving of time at little more expense because of good roads. The railroad loses nothing, for the extra hauls resulting from improved highways more than offset what the roads may take in passenger travel.

California's State Highway has been termed an exhibit of the World's Expositions of 1915, since it stretched from the doors of the Panama-Pacific Exposition at San Francisco to the Panama-California Exposition at San Diego, and must be seen by every 1915 visitor to California whether he travels on it or not.

A motoring authority has compiled estimates on which he bases the prediction that fifty thousand to seventy-five thousand automobiles will travel on the State Highway between southern California and San Francisco in 1915.

BUILDING THE STATE HIGHWAY

How the System of Roads Under the $18,000,000 Bond Issue Is Being Financed and Apportioned

Extracts from Addresses and Extemporaneous Talks by CHARLES D. BLANEY
Chairman California Highway Commission

When one considers that a single through line of the California State Highway, starting at the Oregon boundary and running through the Great Valley to San Diego, is eight hundred and twenty-five miles long, or about the distance from New York to Savannah, Georgia, on the Atlantic seaboard, the fact may be appreciated that the California Highway Commission has found this State one of magnificent distances. On top of this is the fact that every conceivable condition of highway building from the snowfalls of the mountain sections to the intense heat of the desert and from the mountain barriers to sea-level conditions. Hence it must be evident that the construction of the California State Highway is full of more than ordinary problems.

Governor Johnson realized that when he made a selection of the members of the Highway Commission. "You face a tough job," he told us when he called us together; and he said, "you are expected to build for eighteen million dollars a highway system which the best engineers of the country have estimated will cost thirty-five to fifty million dollars."

We started this work with the establishment of a complete system. We inaugurated a merit system for our employees, and every man in the highway work has been appointed solely on his ability to "deliver the goods." We made exhaustive inquiries in the selection of applicants for responsible positions, and every man has had to show a high, efficient rating. We have about eleven hundred men, and there have not been a half dozen changes in the superintending force in the two years.

The men on the State Highway work possess an *esprit de corps* second only to those engaged in digging the Panama Canal, and this has been a marked feature in every department of the work of the Highway Commission.

The State Highway was first planned by an actual observation of the State's needs. The Commissioners and the Highway Engineer traveled up and down the State with an automobile, following the probable roads and visiting sometimes three counties a day, picking up the county surveyor and perhaps the chairman of the board of supervisors at the county lines and taking them over their county roads. Our idea was to abolish many of the natural barriers and run two big trunk roads from Oregon to the Mexican line with no greater grade than six per cent. We covered six thousand eight hundred fifty miles on these tours. We were kicked off mountain roads by mules, we were stuck in river fords, and we slid around dangerous mountain grades; we broke our windshield and punched holes in the bottom of our gasoline tank on the rocks on the desert, and after we had covered the trunk lines and laterals of California from Oregon to Mexico we went back to Sacramento and drew the state highway routes on a big map of the State. We kept a daily log of our trips and every night we went over the day's travel and apportioned to each mile of the road what we believed to be its just share of the eighteen million dollar bond issue. We were endeavoring to give all the counties as fair an allotment as possible of the money apportioned for this state highway.

It was mandatory under the State Highways Act to build one trunk line through the Sacramento and San Joaquin valleys and one along the coast, and also to connect the various county seats by laterals with the main trunk lines. In the selection of roads, too, we had not only to figure on the present population and needs of the districts served, but equally on the probable needs of the future in what is no doubt the fastest growing state in the union; we had to be prophets in a large way. We have taken this up from the outset in a fair and unbiased way, and feel that the fair thing has been done in laying out the State Highway.

The attorney for the Highway Commission has given the following summary of the object of the State Highways Act:

> "The act, undoubtedly, contemplates, *first*, the construction of two main or trunk roads, one along the coast and the other traversing the Sacramento and San Joaquin valleys; and, *second*, that the county seats of such counties as lie east and west of the trunk lines shall be connected to the trunk lines by lateral and tributary highways.
>
> "The object of the statute, in so far as the two trunk lines are concerned, is by directness to afford a means of communication so that the people of the north may be in touch with the people of the south in the shortest interval of time and space, and at the same time linking together those county seats and centers of population which can practicably, and without materially sacrificing directness, be so joined in a trunk line running north and south through the State.
>
> "The laterals are provided for in the State Highways Act for the express purpose of furnishing ingress and egress to and from the trunk lines for such county seats as can not practicably be reached by a direct trunk line; and the ultimate scheme of the state highway system is to cover the State of California with a network of highways which will compact the whole State for the purpose of intercommunication of the residents of every part of the State, and so that no longer will counties be spoken of as being 'remote and inaccessible.'
>
> "The State Highway of California under the present legislation at least, will be but the skeleton for the road system of the State, and local county needs must be supplied by county systems."

When the State Highway shall have been completed, California will have two main trunk lines, coast and interior, traversing the State with practically a six per cent maximum grade, with paved roadways, built and maintained for the most exacting traffic, and with dangerous grade crossings and blind curves eliminated. Any automobile may run over any mile of the completed State Highway on its high speed, and there will be no place on the entire length where the road can not be seen for one hundred yards ahead.

The State alone could meet satisfactorily the problem placed before us, as no private concern or local community could build its roads in accordance with the mandates of the statute.

Our highways are being built for an average of six thousand dollars a mile. When we started out, we were told by various engineers that if our road system was to involve between twenty-six and twenty-seven hundred miles, as we understand it would involve, that we could not build it for less than thirty million dollars. We went into this very carefully, and with a recollection of the manner in which road building problems had been faced elsewhere in this country and in other parts of the world. Some of us have traveled all over the world and studied varying road conditions in the United States and abroad. Our Highway Engineer was an executive on the Massachussetts Road Commission, and is recognized internationally as one of the best road engineers of to-day. So, we were not absolutely without experience, and when we had made the whole route of the system from Oregon to Mexico, from east to west, we revised our apportionment, and to-day we are working on that apportionment.

We took up the fact that backed by its eighteen million dollars, the State can buy its materials in immense quantities and can pay cash for them, and therefore should have the lowest price in the market. We went at it as thoroughly as we could to augment the eighteen million dollars and bring it as nearly thirty million dollars in construction as possible. We said to the cement men who are operating their plants at from fifty to sixty per cent of capacity: "We can increase your output by twenty-five to forty per cent; we are going to pay cash; we are introducing a valuable type of road which will make for increased use of cement in the West, and it is only a business proposition for you to meet this on a business basis and cut your price to the State accordingly." The cement men responded at once, and the State to-day buys cement at an extremely low price, and other materials at a proportionately low figure, probably effecting a saving in buying materials of two million dollars. By furnishing materials to the contractors, equivalent to a credit of fifty thousand dollars, we stimulate competition among contractors, and give a better chance to local men in the various communities, and reduce the price of construction. If we were compelled to pay the ordinary price for cement, we could not build a concrete base under the present bond issue; as it is, we are expecting to pave the greater part, if not all, of the main trunk lines.

We went at it to effect other savings. We decided that the one hundred or more miles of paving of highways through incorporated cities and towns, naturally of more costly character than elsewhere, would restrict our apportionments entirely too much. Hence we decided to build country highways and not to expend the money inside limits of incorporated cities. Another factor which influenced us in this direction was the fact that cities would be compelled to relinquish

control of their streets to the State where the State Highway might be built, and the State would control all improvement matter, which would be rather obnoxious to the city governments.

Then we made an appeal to the patriotism of the counties—and I desire to emphasize right here that I believe no other state can instance any finer demonstration of patriotic response than the manner in which the boards of supervisors and others in California have augmented the construction funds of the State Highway. From Siskiyou and Humboldt counties on the north, through the State to San Diego and Imperial counties, without exception, the counties have contributed rights of way, furnished bridges and also have helped us meet an embarassing financial problem, occasioned by the failure of the bond market throughout the world. This is a splendid demonstration of State patriotism, and is something which will have a prominent piace in the history of California.

When we started at the Oregon line to inspect the probable highway roads, Siskiyou's county board of supervisors said that they would give us a right of way eighty feet wide, and would build all bridges out of their own funds. This has been uniformly the policy of the counties, and has had the practical effect of adding three and one half millions to the mileage money of the State Highway. This has been good business for the counties because they have been given additional mileage, and thus have made a saving in maintenance. The manner in which the counties of small valuations and a large amount of heavy road construction have lined up beside the richer counties in this regard, is extremely encouraging to the Highway Commission.

Another fine example of patriotic cooperation was shown when the bottom dropped out of the bond market, and the State Treasurer was unable to sell the highway four per cent bonds. Every effort was made to market these in the East and abroad after the demand for four per cent bonds ceased early in October, 1912. We had received at that time only two million one hundred five thousand dollars, and it has been found impossible to sell the bonds at par since then. We put this problem before the different boards of supervisors. We explained that the State Highways Act, a referendum law, was rigid in regard to selling the bonds at par, and that the bond buyers were firm in refusing to take four per cent bonds at par. The State could not handle the shrinkage between the par value and the market demand, and we asked the counties to step in and provide this depreciation. We put this before them as a business proposition; they would aid us in securing more immediate construction, and would be relieved of maintenance on the roads taken over as part of the State Highway.

The supervisors of the different counties appreciated our dilemma and have provided funds for making possible the sale of state highway bonds to a total, on June 15, of seven million five hundred five thousand dollars. This has been taken up in the different counties as follows:

Division.	County.	Bonds taken.
I.	Humboldt	$250,000 00
	Mendocino	45,000 00
II.	Shasta	205,000 00
	Siskiyou	100,000 00
	Tehama	332,000 00
III.	Butte	175,000 00
	Colusa	125,000 00
	El Dorado	114,000 00
	Glenn	218,000 00
	Solano	150,000 00
	Stanislaus	75,000 00
	Tuolumne	65,000 00
	Yolo	600,000 00
IV.	Alameda	400,000 00
	Contra Costa	300,000 00
	Marin	150,000 00
	San Mateo	200,000 00
	Santa Clara	228,000 00
	Santa Cruz	75,000 00
	Sonoma	220,000 00
V.	Monterey	45,000 00
	San Benito	125,000 00
	San Luis Obispo	250,000 00
	Santa Barbara	419,074 00
VI.	Fresno	150,000 00
	Kern	410,000 00
	Merced	120,000 00
VII.	Imperial	100,000 00
	Los Angeles	695,000 00
	Orange	400,000 00
	Riverside	100,000 00
	San Bernardino	120,000 00
	San Diego	272,000 00
	Ventura	271,926 00
		7,505,000 00

The foregoing list includes only amounts actually purchased either by boards of supervisors or banks. In addition, further purchases have been pledged by numerous counties, to be made as construction may call for the funds. Humboldt County, for instance, stands ready to take additional bonds to a total of more than one million dollars; Los Angeles supervisors have voted to take five hundred thousand dollars of the bonds, supplementing the amount given, which is a contribution on the part of the Los Angeles banks; Siskiyou County, Colusa County and others will increase their purchases as occasion may require.

It is the intention of the Highway Commission to forward construction as rapidly as possible, consistent with good business judgment and compliance with the legal requirements. The State Highway is not built for a day, but as a permanent road system, and right of way and other preliminaries must be arranged accordingly. In spite of the financial delay the surveys have been carried on without interruption, and nearly two thousand miles of the routes have been surveyed.

Locating Mountain Roads

By Francis G. Somner
Division Engineer, California Highway Commission

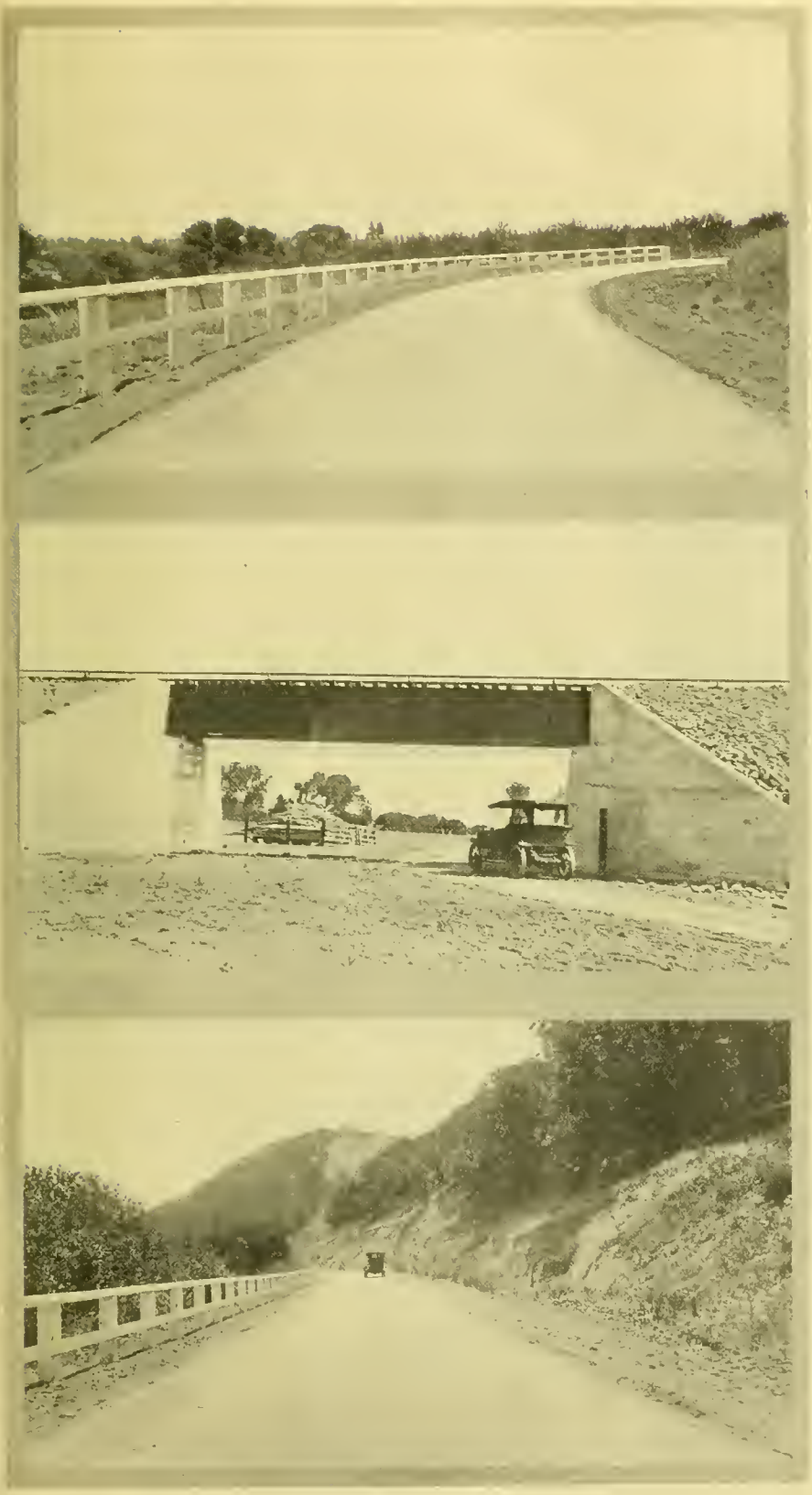
On railroad work, adherence to the standards as regards alignment and grades is rigidly enforced, and although the best results are not always insured thereby, as a rule the policy is necessary and proper; but on mountain highway work conditions are encountered where a choice must be made between an extravagant expenditure of money and a more or less sacrifice of grades and alignment. The theory of economic highway location in such cases may be disregarded where the results to be obtained thereby are commensurate with the traffic requirements and the funds available. The same degree of refinement as regards grades and alignments necessary on that portion of route 1, traversing the Marin County hills, would not be justified in the remote and rugged portions of Humboldt and Mendocino counties, because the traffic does not require it, neither does the topography of the country warrant it.

The selection of a route through the mountains is as a rule controlled, not by the centers of population but by the topography and geology of the country. The location is fraught with a multitude of obstacles which can be surmounted by the application of certain engineering principles, a reasonable amount of physical energy and a vast amount of common sense. The field engineer must not only be proficient technically, but be of vigorous being, both mentally and physically. He should be a natural woodsman endowed with the faculty of arising to any emergency in connection with the establishment of camps and transportation of supplies. It is needless to state that this type of engineer is scarce, for, as Trautwine says, "Nature rarely combines mathematical talent with the practical tact and observation of outward things so essential to a successful engineer."

The writer is familiar in general with the mountain ranges throughout the State and can say without fear of contradiction, that the location of a highway through the mountains of Humboldt and Mendocino is controlled to a greater extent by the geological formations than in any other portions of California. If the cost of construction and maintenance are to be considered at all, the sacrifice of grades to a more or less extent is imperative. These conditions are occasioned by the existence of a serpentine formation, the surface of which to a depth of from five to thirty feet is disintegrated and slips on the more solid formation. These slides generally result during the severe storms in the loss of the entire roadbed, which can be replaced permanently only in the course of time, when all of the disintegrated formation has disappeared. When there is no other alternative except the introduction of a summit, the question arises: Shall we combat the slide at an enormous maintenance expense for an indefinite period, or shall we avoid the slide at a sacrifice of grade? In either case, the traveling public is inconvenienced.

An important factor in the location of the highway through the Eel River country, and particularly that portion in Humboldt County, is the redwood forests, the heaviest body of standing timber in the world. The California Highway Commission, having in mind not only the prevention of wastefulness but also the preservation of the scenic features of one of the most picturesque highway routes in the world, has advocated a winding road, the cutting down of timber permissible only when justified by topographical conditions. This policy is part of the conservation plans extending throughout the entire length of the route through the redwoods, and for some distance either side of the highway.

The width of roadbed is a subject that merits the most careful consideration, inasmuch as it affects the cost more than any other item, at the same time being an important factor as concerns the convenience and safety of the traveling public. The width should be governed by the traffic requirements, topography, and geology of the country traversed, and also by the rainfall. The conditions in northern California are such as to justify a roadbed eighteen feet in width; however, along steep slopes of rock formation a width of sixteen feet should be permissible, extended to eighteen feet on blind curves.



Safety Features of the State Highway

Safety a Factor

Safety for the highway traveler is a dominating factor in the construction of the California State Highway—not safety for the speeder, but for the motorist who uses the roads rationally. Several phases of the safety problem enter into modern highway construction, and they are all exemplified in the State Highway.

Perhaps the most appreciated will be the elimination so far as possible of railroad crossings at grade. Grade crossings where the traffic is heavy, both on railroad and highway, tend to become constantly more dangerous, and where possible the State Highway is constructed over or under the railroad tracks. Where it is not found possible to eliminate the crossing at grade care is taken to make it as open as it can be located and with the best possible view along the track in both directions. In numerous sections of the State grade crossings are cut out where the traffic will be much heavier after the completion of the highway.

In the mountain sections the roads often cross the railroad tracks near a tunnel or cut, where an approaching train can not be seen one hundred feet away. The contour likewise makes it easily possible to stall a motor on the track, so that on the old roads there are numerous crossings with extra hazards. Thirty-four such crossings in the Sacramento canyon division of the State Highway have been eliminated in the survey work of that division.

Heavy fog is often a menace along the seacoast to the motorist who may cross railroad tracks at night, and this hazard would be accentuated if the crossings were allowed to remain at grade on the route near the coast in southern California. The Southern Pacific has co-operated in eliminating eleven crossings of that sort where the fog is especially dense, and this policy has been followed elsewhere.

Safety is also advanced in laying out curves, taking into consideration the necessities of modern vehicles. Some automobile dealers have urged that curves be banked to permit taking them at rapid speed, but all travelers do not care for that excessive precaution, and the curves are made wide and effective for the general traveler. Supervisors, chambers of commerce and officials have cooperated in a number of instances to substitute graceful, sweeping lines for right-angled turns, thus adding to the pleasure and beauty of touring.

The mountain roads will show the greatest safety improvement, and the mountain sections of the State Highway will appeal to the most timid women who have heretofore rejected touring in some of the most delightful portions of California because of the danger involved. The State Highway will be wide enough in the mountains, its edge will be protected, and nowhere will there be a dangerous grade. Nearly all the grades will be within a six per cent maximum, and there will be a few miles of seven per cent. That is easy enough for a horse and delightful for an automobile.

Safety is also promoted where flood conditions are apt to affect roads in winter. Bridges are constructed as permanently as possible, and efforts are made to avoid flood damage.

From the very beginning the aim has been to make the State Highway "safe, sane, and economical."

Road Oil Specifications and Tests

By Clarence B. Osborne,
Geologist, California Highway Commission.

The finished road surface will be subjected to the pounding impact of the iron-shod horse, the pulverizing grind of the steel-rimmed wheel and the pulling-upward suction of the rushing rubber tire; these make up the modern forces of traffic which forever tend to crush, grind, displace and scatter the road surface. There is no material that can, unaided, continue to withstand such an attack. To these destructive agencies of traffic are added the erosive action of storm waters, the disrupting forces of frost, the theft of material by the sweeping winds, and the melting and drying action of the hot sunshine.

In the preparation of specifications for asphaltic oil for road building the road engineer has three problems presented: *first,* he must have requirements controlling the chemical purity of the oil, *i.e.,* he desires an oil that is free from foreign material and products of decomposition produced during refining; *second,* he must control the chemical composition of the oil; *third,* he must control the physical properties of an oil so that it will actually perform its proper function in the road construction.

Specifications for chemical purity of road oil are as follows:

1. It shall not cantain more than ane half of one per cent of sediment by volume.

The presence of even ten times this amount of sediment is not detrimental, as the oil in use on the road eventually carries as high as ninety per cent of mineral aggregate. This specification is used to prevent the buying of sediment at the price of road oil.

2. It shall not contain more thon one per cent of woter by volume.

The presence of water in a road oil makes the oil difficult to handle when heated above 212 degrees Fahrenheit, because the steam formed makes the oil boil or froth. Also, as in the case of sediment, unless the proper deduction is made water will be paid for at the price of road oil.

3. It must, when freed from water, be soluble to ot least ninety-nine and five tenths per ent (99.5%) in pure carbon disulphide.

This will give the per cent of bitumen in the road oil.

4. The bitumen soluble in carbon disulphide must be soluble in carbon tetrachlaride ta the extent of at least ninety-nine per cent (99.0%).

The failure to pass this specification is supposed to be an indication of an over-heated or "cracked" oil. Carbon tetrachloride is not a stable solvent in bright light and the solubility test is influenced if the test is performed in bright light.

Another specification sometimes used to determine a "cracked" oil is as follows:

5. In CS2 bromide solution. The bitumen soluble in carbon disulphide must be soluble to the extent of ot leost ninety-nine and eighty-five one hundredths per cent (99.85%) in a solution of ane hundred and thirty-five (135.0) milligroms of bromine to one hundred (100.0) cubic centimeters of the corbon disulphide, when twenty-five (25.0) cubic centimeters af the solution are poured on twa (2.0) grommes af the oil in on Erlenmeyer flosk, which is then shaken in the dark for three (3.0) minutes, the solution being immediately filtered through o Goach crucible using a suction equol to a column of mercury more than eight (8.0) inches high.

When the solution has all passed through the crucible, the crucible is woshed with pure carbon disulphide, dried at from two hundred and twelve (212.0) ta twa hundred ond twenty degrees Fahrenheit and weighed.

This test had its origin in the examination of vegetable and animal fats. The unsaturated fatty acids form insoluble bromides. This bromide carbon disulphide solvent is not stable, however. An oil having an excess of fifteen hundredths of one per cent of insoluble material would fail to pass this specification, and yet this failure might be due entirely to the unstable solvent.

The specifications to govern the different constituents that make up the bitumen of the road oil are partly included in the specifications numbered 3, 4 and 5.

The road oils are generally classified as to their asphalt content. This asphalt is not a definite chemical compound determined by chemical analysis. To determine the asphaltic content, the road oil is hardened by heating it in an asphalt oven at a high temperature. Part of the light or volatile oils, is driven off in this heating and the residue is hardened. The degree of hardness is measured by the depth of penetration of a No. 2 needle when acting under a load of 100 grams for five seconds, the residue being maintained at 77 degrees Fahrenheit. If the needle penetrates 8 millimeters in this test the residue, called asphalt, is said to be asphalt of 80 penetration. As can readily be seen, this residue may contain many different bitumens. The test is not a measure of a definite chemical compound.

If the assayer for copper should call all the metal extracted "copper" when the metal was of a certain hardness, then it can readily be seen that any alloy of soft and hard metals that made this certain hardness would be classified as copper. This is the practical result of the specification for a road oil when it is required to contain a certain percentage of asphaltum.

The early oil bound macadam roads built with asphaltic oils usually required an oil containing 70 to 75 per cent of asphalt of 80 penetration. This oil was not heavy, that is, it lacked body (*i.e.,* low viscosity), and it was a weak binder but it was easily applied to the road surface.

The use of pressure tank wagons with sprayers for applying heated road oil has made it possible to use an oil of much higher asphalt content and of higher viscosity. The road oil that is now commonly demanded for oil bound macadam, or for bituminous covered concrete highways, is one that contains 90 per cent of 80 penetration asphalt. The following specifications are suggested for such an oil:

6. It sholl contain 90 per cent of 80 penetration ospholt.

This per cent of asphalt is determined by heating 20 grams of the road oil in a two ounce salve tin in a standard asphalt oven, the temperature of the oven being maintained at 400 degrees Fahrenheit. When the asphaltic residue has a penetration of 80, the oil shall not have lost in excess of 10 per cent by weight.

The asphaltic content is the classification of the oil refineries of their different grades of road oil. The specification is of value more on this account than for any information of practical value furnished to the road builder.

7. It sholl show on open flosh point not less than 350 degrees Fahrenheit.

This requirement prevents the use of an oil carrying very volatile constituents that would readily evaporate and might also be dangerously combustible at the time the oil was being sprayed on the road at the high temperature necessary for spraying.

The physical properties of a road oil are of the greatest importance to the road builder. The following specifications deal directly with the measurement of the important physical properties:

8. It shall show o float test of nat aver 1000 seconds when tested at 90 degrees Fahrenheit. This test is described in Bulletin No. 38 issued by the Office of Public Roads, United Stotes Department of Agriculture.

This float test is the measurement of the viscosity of a road oil. The requirement will prevent the use of excessively viscous road oil, one that is difficult to apply and is slow to absorb the mineral aggregate necessary to the building up of the proper wearing surface.

9. The oil shall show o specific viscosity of not more thon one hundred (100) when tested with the Engler viscosimeter ot a temperoture of two hundred and twelve (212) degrees Fahrenheit.

This test will prevent the use of an oil that is too viscous to be readily applied to the road surface from the oil spraying wagon.

10. It sholl show an odhesive test of not less than 300 seconds far three revolutions with the Osborne adhesive machine, when the oil is tested ot a temperature of 77 degrees Fahrenheit, the load being 3 kilograms.

This test is the measure of the oil's power to prevent relative motion of two concentric cylinders when the oil acts as a binder between the surfaces of the two cylinders. The inner cylinder is 1.995 inches in diameter, the outer cylinder is 2,000 inches in diameter, the outer cylinder being in the form of a loose collar two inches wide. Its inner surface is coated with the oil to be tested. The outer surface of the inner cylinder is coated with oil and the collar then forced on the inner cylinder, which is maintained in a stationary position. The outer collar is wound with cord to which a three kilogram weight is attached; the pull of this weight causes the collar to revolve; the thin film of road oil between the two cylinder surfaces offers a resistance to this turning. The temperature of the oil being tested is maintained at 77 degrees Fahrenheit by means of water circulating in the inner cylinder. The measurement of the adhesive value of the oil is the length of time required for three complete revolutions of the collar.

Oils containing the same percentage of asphaltum will often show the greatest difference in their binding properties. Oils possessing the same viscosity will likewise often show a wide difference in adhesiveness.

As an example, one oil may be largely made up of heavy lubricating grease, another may be very free from lubricating material but they may both flow through a given-sized orifice at the same rate, when heated to the same temperature, that is, they have the same viscosity. The lubricating oil would lack binding power and be unsatisfactory for road construction; the other would be desirable. The adhesive specification would prevent the use of the unsatisfactory lubricating oil.

The asphalt contained in a road oil is required by some road builders to possess a certain ductility.

11. The ductility of the aspholt which hos been reduced to o penetration between 75 ond 85 shall not be less thon 110 centimeters.

This test is made with asphalt maintained at 77 degrees Fahrenheit and the pulling shall be at the rate of five centimeters per minute, using the Dow ductility machine.

There is a woeful lack of uniform specifications for road oil and uniform methods of performing the tests. In the determination of the asphaltic content of an oil, the temperature for the asphalt oven is specified sometimes at 325 degrees Fahrenheit, and from that to as high as 500 degrees Fahrenheit. The dish containing the road oil during the reduction is in some laboratories as small as a thimble, and in others, large enough to hold 500 grams; sometimes cylindrical, and other times semispherical in shape. Some tests require the use of an oven, others require heating in the open air. As has been shown, the "asphaltic content of an oil" is, at best, a rather indefinite term, and when we have added to this the different methods used and the wide range of equipment used, the "asphaltic content" becomes even more of a vague description.

The asphaltic road oils are, for the most part, a by-product of the oil refineries. They are a relatively cheap material. This cheapness saves the road oils from being adulterated with other material. It is expensive to add anything to the oil. The natural oil itself rarely carries undesirable material. The tests for water and sediment will take care of foreign materials brought in by the crude oil.

Some road engineers have regarded oil containing sulphur as dangerous to use because the sulphur is supposed to make the product unstable. Many oils and asphalts carrying sulphur have given good service for long periods of time, and if sulphur does tend to make the oil unstable, this action is too slow to be of importance in the life of the oil used in the road construction.

SURVEYOR INSPECTS HIGHWAY

Expert Report of W. L. Luning, of Tehama County, Commends Construction and Specifications

When the board of supervisors of Tehama County was requested by the California Highway Commission to cooperate in making marketable a sufficient number of state highway bonds to finance construction in that county, it was deemed just to the people of Tehama County to make a close investigation of the character of the state highway construction. Since no construction has been completed in Division II, the people of Tehama County have no close opportunity to investigate

Forty-foot Wave on Rincon Route, State Highway. During Last Winter's High Tides This Sea Level Road Withstood Severe Onslaughts of Ocean and Flood Waters.

the character of work, and they have been assailed by conflicting reports as to methods of construction.

The Supervisors and the Red Bluff Chamber of Commerce accordingly joined in requesting W. L. Luning, county surveyor of Tehama County, to make a personal investigation of the State Highway. Mr. Luning has been county surveyor of his county for a quarter of a century, and is well known all over northern California as an authority on highway construction. He made, on his own initiative, a thorough investigation and on his return submitted his report to the Red Bluff Chamber of Commerce, of which the following is an extract:

"There being publication and criticism to the effect that the Highway Commission were constructing some inferior roads, and in some instances there were portions of the road going to pieces, and they were not constructed in a permanent manner, the part of the committee work allotted to me was to inspect some of that portion of the State Highway that has been criticised.

"We went all over the State Highway constructed between San Francisco and Santa Clara. The State Highway is not continuous between the two points above mentioned. It is disconnected by corporations and portions that have not yet been constructed. We traversed twenty-three miles of constructed State Highway, while we were from where we started forty-eight miles.

"A portion of this State Highway is paved twenty-four feet wide and a portion twenty feet wide. The road paved varies in width according to the amount of travel. I find the worst-paved road between Centerville and Santa Clara. There were three or four places where the concrete was broken, each place being about two feet in diameter. This may have been caused by an improper mixture, or by being used before the concrete had time to set. On this same piece of road there were numerous places where the

Farthest North on California State Highway. Hills in Foreground Are in California; Those at Right Are in Oregon

asphalt did not adhere to the concrete base and the concrete was exposed but not broken. This may have been caused by the concrete being wet, as I was informed that this road was constructed in wet weather.

"I met John MacBain, a supervisor of San Mateo County, whose post-office address is Menlo Park. I told him my mission; in conversation with him he told me that there was not a particle of constructed State Highway in San Mateo County that was bad. I found his statement to be true.

"While I think there is no need for me to go into all minor details of construction, I will say that I find this portion of the State Highway in good condition except the small portion above referred to, and it was not caused by faulty specifications. Because there were three or four holes in the roadbed and the asphalt finish did not adhere in a few places, the whole road should not be condemned.

"The specifications for the construction of the State Highway are good. I myself thought the four-inch concrete base was too thin, but I saw the road in places constructed on high fills which have been thoroughly watersoaked this winter and the paved road bed has withstood it all, and is in fine condition."

The supervisors of Tehama County are financing the construction of $450,000.00 of State Highway through that county.

Highway an Empire Developer

The Shasta County Promotion and Development Association recently made the State Highway and irrigation as the main planks in its platform, and an active county campaign has been carried out along those lines by the secretary, R. J. Anderson. A leaflet has been printed and widely distributed with the heading, "Opening and Developing an Empire," and beginning with the following paragraphs:

"The building of the California State Highway, which means a paved street from San Francisco entirely through Shasta County on to Portland, is opening up an immense empire for settlement.

"Such a road as this will bring into our county the very best class and character of settlers, people who have the money to help us develop our vast resources, and who will take a pride in seeing that our development is on a substantial and profitable line."

CONSTRUCTION PROGRESS ON CALIFORNIA STATE HIGHWAY

FEATURES OF THE STATE HIGHWAY

Conquering Oldtime Barriers, Opening Rich Sections for Motor Truck Traffic, and Other Benefits Considered in Highway Construction

By N. D. Darlington
Member, California Highway Commission

The State Highway is primarily designed to meet the commercial needs of the State of California and to provide better means of communication than is afforded by our present road system. In planning highway construction under the authorization of the State Highways Act, and with the foregoing in mind, there have been developed, of course, features of special interest in road building. There are as well other features only indirectly allied to the state highway work, but which are important to the people of California.

In conquering the mountain barriers changes are required to produce a modern highway which may be considered features of the state highway work. The Commission has met several problems of this sort in different parts of California, and has endeavored to solve them with a maximum grade of six per cent where practical, or, at the most, six and one half or seven per cent. This policy has been criticized, but no doubt the critics have not fully realized that the word "permanent" is prominent in the mandates of the Highways Act, and that the roads as laid out must be planned to be good roads for years in the future.

Our mountain ranges heretofore have been veritable barriers to travel on account of the excessive grades on the present roads. These obstructions to the flow of traffic have been overcome by replacing the present tortuous roads with their steep grades with modern highways of good alignment and easy grades. Bailey's Hill, at the northern entrance to California, has had such a road winding down from Oregon; it will be supplanted by a highway with a grade not over six to seven per cent, and the Oregon road builders have taken California's standard and are coming over the Siskiyou mountains to our state line with a six per cent maximum. In the Santa Cruz mountains a splendid road with no steep or dangerous grades will form part of the State Highway. Across the range between the San Joaquin Valley and southern California the new highway will eliminate many miles of distance as well as bad grades, and will offer a magnificent panoramic road. The dangerous Casitas Pass is supplanted by the sea-level Rincon route along the coast between Santa Barbara and Los Angeles, a feature in which the state highway work has been materially aided by public spirited citizens. The road from El Centro to San Diego will furnish those living in Imperial Valley with a direct outlet to the coast over a road which will be unsurpassed for beauty and interest.

The mountain roads of the State Highway will prove more valuable, I believe, in their purely commercial aspect than in the pleasure they give to tourists. The commercial motor vehicle is a most important factor, and its development has but started. In Los Angeles County, following the establishment of a comprehensive system of good roads, the number of motor trucks increased from sixty-four to thirty-two hundred in four years, and the best informed motor truck men of Los Angeles regard six thousand trucks as a normal number for use in that county. A similar, although not so rapid increase, is to be observed in all parts of California. The State Highway will make the motor truck an adjunct of the rancher, and thus will come an important development of California's resources. The same thing is true of the county highway systems which are planned in this State.

During the past rainy season numerous ranchers found it necessary to make three and four trips on unimproved roads as far as the State Highway, where they piled the loads until they had enough for one load to take into town on the paved highway. That experience demonstrated the commercial value of a good road. There are numerous rich sections of California where hauling economically all winter is out of the question without a road that will give good service in bad weather—when it is most needed.

A feature of special importance is the shortening of routes between sections of the State. The Yolo causeway across the by-pass of the Sacramento River west of Sacramento is a feature of this sort. It will require about three miles of concrete trestle, but will be of service to the entire State and will materially shorten the distance between Sacramento and the San Francisco bay cities.

In opening up a permanent route through the redwoods to Humboldt and Del Norte counties there will be provided an important feature of the State Highway. In addition to advancing the commercial interests of the northern California coast the route will prove a magnificent touring attraction. It will run for miles through stately redwoods, giant trees several thousand years old, where at times the sun is obscured by the forest, making a trip long to be remembered. This is a feature of California which by all means should be preserved. The redwoods of northern California tell the magnificent proportions of the State's resources in so stately a way that a state park ought to be planned comprehensively while it is feasible to do this, and it should be planned so that the tourists who take that route of the State Highway should realize the importance of this feature of touring in California. This is a matter of conservation and beautification which the women of California should take up through their various organizations and carry to an achievement.

The greatest feature about California's State Highway is that the expenditure of eighteen millions as a precursor of the State's complete road development fits into the new era of California so remarkably. We can not realize the development California has just ahead, and yet in all parts of the State preparations are being made now for that development. The State Highway will be completed just at a time when it will prove an invaluable factor to the communities and counties in faciltating the development of the next decade.

ACCEPTANCE OF BRIDGES

Walter C. Howe, division engineer, California Highway Commission, said in discussing "County Bridges," at the March, 1914, Seminar of Highway Department Heads:

"I believe that the acceptance of all long span bridges by the State should be very carefully considered. The recent floods took out many heavy steel bridges in Division V. The lesson taught was a very valuable one to the counties. Many of the hridge failures were due to faulty pile foundations and consequent settling of piers; others were due to improperly designed abutments, but the principal and most important lesson taught was the urgent necessity for proper protection of the river banks to prevent continued erosion. On every river in this division the erosion of the banks from the 1914 floods is the one big problem, and this problem should be solved before the acceptance of bridges menaced by this danger, for it may easily happen that a 700-foot bridge accepted to-day may be an isolated structure to-morrow, and the expense of all the additional spans necessary to bridge this gap made by the flood waters, would, I assume, have to be borne by the State if the original structure and its approaches had been fully taken over and accepted."

In discussing the same subject, R. E. Dodge, office engineer of the Highway Commission, gave the following summary of the method of changing plans for county bridges:

"At present most of the plans and specifications for county bridges are being submitted to the headquarters office for examination. The plans are checked sufficiently to detect any dangerous weakness in design and to find out whether the structure will carry the Commission's prescribed loading at safe working stresses. The attention of the county officials is called to any defects, and sometimes remedies are suggested. No attempt is made to have plans revised so that the structures may be the best or most economical for the place. The specifications are looked over, and any parts that do not call for proper material or work are criticised. It is not possible, however, to study specifications sufficiently to make sure that nothing is omitted, or that they are in the best form for the job. The responsibility for field inspection in behalf of the State, is placed upon the division offices. The inspection which appears to be contemplated is not for the purpose of enforcing specifications or insuring good work, but for the purpose of gathering data upon which to base, in part, acceptance or rejection."

PROBLEMS OF HIGHWAY CONSTRUCTION

Difficulties in the Work of the California Highway Commission in Building the State Highway

By Austin B. Fletcher, Highway Engineer.

The State Highways Act, under which the state roads are being constructed, provides in no uncertain words that the State is to maintain the roads after they are built. The Motor Vehicle Act, through the fees which it specifies for the registration of motor vehicles, will provide the money, since one half of the net receipts goes to the counties for the maintenance of county roads and the balance to the state highways for their upkeep. Estimating conservatively, there should be available from this source for the state highways during the year 1914 from $350,000 to $400,000.

The chief immediate use which the Commission has for a maintenance fund is for placing gravel or macadam shoulders along the paved portions of the roads built and to be built. In many localities the natural soil under and beside the paved portion of the roadway is not sufficiently stable during wet weather to sustain even the occasional wheel which gets upon it, and it is of course necessary that at times the shoulders of the roads should be able tc carry some traffic.

It did not seem possible to provide for such shoulders in the original construction because of the eost of such work and the necessity for conserving as much as possible of the eighteen million dollars appropriated for construction purposes. The maintenance fund also permits of the purchase of equipment for repairing and maintaining the roads, which is costly and which can not be rented economically. Maintenance problems and those of construction, in highway work particularly, are almost inseparable, and in choosing a type of road or pavement the future must always be reckoned with.

The greatest problem of all confronting the California Highway Commission is how to build nearly two thousand seven hundred miles of state highway with eighteen million dollars in such a manner that the people will be reasonably satisfied, and so that the roads will not cost excessively for maintenance. This means that on the average, including administration expenses, the roads must not cost more than six thousand six hundred dollars per mile, which is obviously too little if the whole system is to be paved.

As a result of much deliberation the Commission adopted as a standard type of paving to meet the average conditions a Portland cement concrete roadway fifteen feet wide, protected by a thin surfacing of asphaltic oil combined with stone screenings. This does not mean that all of the state roads are to be so constructed, for some of the roads have already been paved to a width of twenty-four feet, where the traffic seemed to require it, and surfaced with asphaltic concrete. Nor does it mean that all of the roads will be paved, for in some of the mountain counties such a treatment would be absurd under present traffic conditions.

There are now under contract about three hundred fifteen miles of concrete road on which the thin top is to be placed. About fifty miles of the thin top has been put on, and on all but a very few miles it is giving admirable service.

The history of the thin top or carpet is interesting. For many years, and until about the year 1906, the broken stone road first developed in England by John L. Macadam, and perfected for American requirements by William E. McClintock of Massachusetts, was considered the last word in rural road building. The Eastern States were all constructing their state highways of that type, and the roadbuilders were a self-satisfied lot. In 1906 the writer was chosen by the Government Office of Public Roads to prepare a bulletin on the subject, and he well remembers his feeling of pride when he was told that over two hundred thousand copies of his bulletin were to be printed and distributed. The writer also well remembers that but two years later at a road meeting at Buffalo he was obliged to confess that "the macadam road is a thing of the past" because of the ubiquitous automobile.

The case, however, turned out to be not so bad as was then predicted, for after experimenting with applications of hot asphaltic oil or refined tars and sand spread upon the cleaned macadam roadways, a method which the French probably first discovered, it was found that a thin bituminous carpet from one fourth to one half an inch in thickness was developed, which served to prevent the raveling of the stones composing the pavement. There are thousands of miles of macadam road in the Eastern States treated in this manner, which are now giving ample satisfaction even to that most captious critic, the automobile owner.

In the year 1908, almost simultaneously in Ann Arbor, Michigan, and in Spencer, Massachusetts, sections of eoncrete roadway were covered with a similar bituminous carpet of refined tar and stone screenings. In the Massachusetts case, with which the writer is more familiar since the work was done under his direction, the bituminous covering was applied to lessen the roughness of a section of concrete pavement built by the Hassam process. Both the Ann Arbor experiment and that in Massachusetts were successful, and the carpets gave good service, lasting two years and more with almost no expense until it came time to renew them by precisely similar applications of tar and screenings. Within the last few years many thousands of square yards of concrete have been so covered with bituminous carpets, and the Ann Arbor engineer who thought out the scheme has even applied for letters patent on the process. The patent has not been granted yet, so far as the writer is aware.

It was these experiments in the Eastern States which led the California Highway Commission to consider the bituminous carpets for the California roads. The only essential difference between the work in the East and that here lies in the use of heavy asphaltic oil instead of tar. It was not possible to use eoal tar in California without long railroad carriage and correspondingly high cost, for it is not produced here in any considerable quantity. The writer, however, has no regret on that account. The bituminous earpets, using California asphaltic oil on ninety per cent of the work already done, are far superior in his judgment to the tar and screening earpets of the East which he has inspected. They are also far superior to the bituminous carpets usually applied to the macadam roads in the East, and he asserts, after more than twenty years' experience in state highway work, that no eastern state is to-day getting its state highways constructed so cheaply, so thoroughly, or surfaced so satisfactorily as is California.

Two trips made by the writer to England and France during the past five years have convinced him also that in the construction of our roads we ean learn little there. They are still laying the bituminous carpets on waterbound macadam roads, or, where the traffic is heavy, mixing tar with slag or broken stone and forming a crude bituminous macadam roadcrust not nearly so good, in the writer's opinion, as the asphaltic concrete work done in California. As to maintenance problems, that is another story.

California started late with its state highways. Its people, with the changed conditions of traffic brought about by the automobile, are demanding what to all intents and purposes is city street work out in the country. And California is getting it, to all intents and purposes.

The Commission has had some poor work foisted upon it. In Sonoma County there was some concrete thinner than called for by the specifications, but that has not been paid for, and the poor work will be done over before the road is completed. In Santa Clara County the writer made the error of allowing some asphaltic oil of too heavy grade to be used, which, because of the climatic conditions at the time of its application, did not make the bituminous carpet of the thickness and quality desired or expected.

Based upon these instances the report has been circulated widely that the state highways are crumbling; that they are a laughing stock. Almost any expression of contempt has served. It has even been said —God save the mark!—that they have been hastily built. Mark Twain said somewhere: "The chief difference between a cat and a lie is that the cat has only nine lives."

The people on the peninsula do not believe such nonsense, nor do the people in the San Joaquin Valley, nor in Los Angeles County, nor in San Diego. Nor, indeed, do the people of the State generally, or their actions belie their deeds. They believe in the kind of roads the Commission is building to such an extent that since October, 1912, they have financed the construction by purchasing state highway bonds to the extent of nearly seven million dollars.†

The Commission has had some difficulty in making the people of some localities believe that the law [State Highways Act] means what it so plainly says. Many hearings have been given and much time consumed

*Extracts from a paper read before the Commonwealth Club of San Francisco, Marcb 14, 1914, on "Some of the Problems and Accomplishments of tbe California Highway Commission."

†The sale of state highway bonds made possible through the cooperation of California counties and banks amounted on June 15, 1914, to a total of $7,505,000.00. There is not at this date a market demand at par for tbe bonds because tbey yield but four per cent interest.

in listening to advocates for particular routes who wished the course of the state highway diverted from what the Commission considered to be the most direct and practicable lines. It is believed that the people of the State have now come to a better understanding of this matter and realize that the State Highway is to be built for all of the people and that it can not be diverted from its course for purely local requirements.

The writer, in closing, feels that it is but fair to recite briefly some of the other achievements of the Commissioners in the promotion of state highway work, for which he thinks that they are entitled to the everlasting thanks of the people of California:

They have brought about the policy that the counties shall furnish without cost to the State all land needed for the right of way of the State Highway.

They have induced the counties to build and pay for all new bridges exceeding twenty feet in span along the line of the State Highway.

They have caused the cities and incorporated towns along the route to agree that the streets within their corporate limits should be paved and maintained by the municipalities.

They have induced the railroads, over which hundreds of thousands of tons of materials must be transported, to reduce their freight charges so that such materials will be moved at approximately one half rate.

They have saved many thousands of dollars by purchasing road materials in large quantities.

They have, by careful studies of the location of the State Highway, obviated crossings with railroads at grade in many places. In Ventura County alone, within a length of twelve miles, nine grade crossings will be abolished.

They have provided for two trunk lines between San Francisco and Los Angeles, one by the coast and the other by the valleys, the first requiring about three hundred and eighty-four miles of construction and the latter three hundred and twenty-three miles, which will be paved, and which will nowhere have a grade in excess of six and one half per cent and not more than two or three miles in excess of six per cent.

SEMINAR OF HIGHWAY HEADS

Engineers and Other Officials of Highway Commis sion Hold Meeting for Exchange of Experiences in Construction

A seminar of department heads of the California Highway Commission was held at Sacramento March 26th and 27th, on call of the Highway Engineer. Those attending had been assigned topics affecting the constructing of the State Highway, and others were given discussions so that a general interchange of views and experiences resulted.

Chairman Charles D. Blaney of the Highway Commission made the opening address welcoming the department heads, who came from all sections of the State where the highway is under construction.

At the opening session the following papers were presented and discussed: "Civil Service as It Affects the Employees of the Commission," by Charles C. Carleton, attorney for the Commission, with discussion by W. Lewis Clark, division engineer; "Accounting," by J. H. Small, chief accountant, with discussion by T. E. Stanton, Jr., principal assistant engineer of Division VI; "Purchasing," by H. L. Warren, purchasing agent, with discussion by George Mattis, principal assistant engineer of Division V; "Surveys and Drafting," by T. A. Bedford, division engineer, with discussions by S. V. Cortelyou, principal assistant engineer of Division VII, F. W. Haselwood, principal assistant engineer of Division I, Samuel S. Stahl, principal assistant engineer of Division III, and Russell H. Stalnaker, principal assistant engineer of Division II; "The Testing of Materials," by C. B. Osborne, geologist for the Commission, with discussion by J. B. Woodson, division engineer.

The second session composed the following papers and discussions: "County Bridges," paper by Walter C. Howe, division engineer, with discussion by R. E. Dodge, office engineer at headquarters; "Rights of Way," by C. C. Carleton, attorney, with discussion by George B. Harrison, chief of right of way department; "Day Labor versus Contracts," by William S. Caruthers, division engineer, with discussion by F. G. Somner, division engineer; "Publicity," by George B. Harrison, editor of the "California Highway Bulletin," with discussion by Wilson R. Ellis, secretary of the Commission.

Papers presented at the second day's meeting were as follows: "Drainage," by Arthur E. Loder, division engineer, with discussion by W. Lewis Clark, division engineer; "Mountain Roads," by Francis G. Somner, division engineer, with discussion by T. A. Bedford, division engineer; "Inspection on Contract Work; How May Its Cost Be Lowered?" by L. H. Gibson, second assistant Highway Engineer, with discussion by A. E. Loder, division engineer; "Extra Work Orders and Permits," by George R. Winslow, first assistant Highway Engineer, with discussion by William S. Caruthers, division engineer; "Concrete Bases," by J. B. Woodson, division engineer, with discussion by L. H. Gibson, second assistant Highway Engineer; "Thin Bituminous Tops," by W. Lewis Clark, division engineer, with discussion by J. B. Woodson, division engineer; "Asphaltic Concrete," by A. E. Loder, division engineer, with discussion by Walter C. Howe, division engineer; "Cost Data," by A. B. Cleaveland, assistant engineer, with discussion by R. K. West, principal assistant engineer of Division IV; "Maintenance," by J. B. Woodson, division engineer, with discussion by A. E. Loder, division engineer.

Officials and department heads of the Highway Commission were entertained at a dinner at the Sutter Club by the Highway Engineer, with Governor Hiram W. Johnson as the guest of honor. The Governor, State Engineer McClure, and Commissioners Blaney, Darlington and Stern, made informal talks.

All the sessions of the seminar were given over to a running discussion of the subjects, and the members of the Commission and department heads exchanged views freely at all times, resulting in a valuable series of experiences. The seminar will be repeated at a future date.

Several of the articles appearing in this number of the "Highway Bulletin" are taken from the papers and discussions at the March seminar.

Changes

Burton A. Towne has resigned as a member of the California Highway Commission and an appointed member of the Advisory Board of the State Department of Engineering, owing to the pressure of private affairs. Mr. Towne was one of the original members of the Commission, and was elected chairman upon its organization, holding that place until his resignation was accepted. Governor Johnson appointed Charles F. Stern, of Eureka, in Mr. Towne's place, and the Highway Commission elected Commissioner Charles D. Blaney as its chairman.

Wilson R. Ellis, who has served as Secretary of the Highway Commission since its organization, has requested and been granted a leave of absence until November 1st, and Charles C. Carleton has been made Acting Secretary. Mr. Carleton will continue his duties as Attorney for the Commission while serving as Acting Secretary.

Reconnoitering along Shasta River; Commissioner Stern in Center of Illustration.

Surveying and Building Mountain Roads of State Highway

PERMANENT ROAD CONSTRUCTION

In answer to an inquiry for information on permanent road construction, Highway Engineer A. B. Fletcher recently made the following reply to a California correspondent:

"At the outset I have to confess that I know of no type of pavement which can truly be called 'permanent,' and the expression must be considered as only relative. I know of no pavement or roadway which does not require from the day it is constructed more or less expenditure for maintenance. If no other work is needed for the first few years the roadsides, gutters and culverts have to be looked after.

"As concerns the pavement proper, I believe of the types within the means of the more opulent states and counties at the present time that most nearly approaching the ideal consists of a concrete base of thickness sufficient to properly sustain the traffic which it must carry with a wearing surface of asphaltic concrete from one and one half to two inches thick.

"Such a pavement twenty feet in width and with the base only four inches thick would probably cost under the conditions in your county not less than $14,500 per mile for the paved portion of the road, assuming that the concrete can be laid for $6.25 per cubic yard and the asphaltic concrete surface for six cents per square foot. To this must be added the cost of grading, culverts, drains and any special treatment of the shoulders or beams on the sides of the pavements.

"Few of the states and hardly any of the counties with which I am familiar can afford so great an expenditure per mile.

"In the instance mentioned a thickness of concrete base of four inches was assumed. In my opinion so thin a base should be adopted only when the subgrade is of excellent quality both as concerns the material composing it, and the rolling done upon it to make it compact and unyielding, and when the inspection of the construction is adequate. Eternal vigilance is necessary to prevent construction of the base thinner than the specifications provide for.

"If the base be increased in thickness to say five inches, one fourth must be added to its cost or about $2,000 per mile, making a total probable cost of $16,500 per mile.

"It was early apparent to the Commission in its State Highway work that no such road as has been discussed above was possible if justice was to be done to all parts of the State. The main routes, requiring paving aggregating about 1,300 miles in length (less than one half of the total mileage called for by the State Highways Act), if built as above described, but with the paving only fifteen feet wide, would cost, grading and culverts included, more than $16,000,000 and adding the overhead expense there would be almost nothing left for the other half of the system.

"This consideration led the Commission to seek a type of road cheaper in first cost, notwithstanding a consequential higher maintenance expenditure during the early years of its existence and the type called 'concrete base with bituminous top' was adopted rather generally.

"In this method of construction, the base is the same as if the one and one half to two inches covering were to be applied, but instead a thin coating of asphaltic oil of special quality is put on to the concrete by spraying machines at the rate of about one half gallon to the square yard. Clean stone screenings or coarse sand are then added in sufficient quantity to absorb the oil. The process requires much care in the selection of the materials used and in their manipulation, but the result is a bituminized coating about three eighths of an inch thick. The cost of such surface work ranges from five to ten cents per square yard, or $600 to $1,200 per mile, roughly, for a twenty-foot pavement, depending on the cost of materials and local conditions. This means that more than ninety per cent of the cost of the work on the road goes into grading, culvert work and the concrete base, all of which may be considered as practically permanent, and the remainder into the thin wearing surface.

"Such a wearing surface should last from two to four years before it requires renewal, which renewal should cost considerably less than the original application. The thin surface is best adapted to rubber-tired vehicles, but it wears well under a considerable volume of mixed traffic consisting of both rubber and iron-tired vehicles.

"I would have no hesitancy in recommending the thin road surface for a road covering as many as from five to six hundred vehicles a day, provided a considerable portion of the vehicles are rubber tired.

"If the concrete is covered with a thick one and one half to two inch coating of asphaltic concrete, under ordinary conditions, there will be but little cost for maintenance except on the roadsides and for cleaning culverts for the first five years, but after that period the surface will require attention from time to time in patching and applying seal coats, and when the road needs a new surface, it will doubtless be found that the maintenance cost has been in excess of two and one half cents per square yard per annum.

"Another type of road which the Commission has constructed to the extent of nearly twenty miles is the so-called 'oil macadam' road. When properly built, I consider this type of work worthy of adoption in many cases, but it has been found, in this State at least, that it is very difficult to secure uniformly good results. There are many contributing causes to the failures or partial failures and the Commission has favored the cement-concrete type because of the greater certainty of result and because also the concrete so far has cost about the same as 'oil macadam.'

"My experience in the East leads me to believe that the 'oil macadam' pavement costs for maintenance not much less per mile per year than the cement concrete base with thin asphaltic top, and this is borne out in the case of the San Joaquin County work here in California. Los Angeles County has constructed many miles of this sort of road and the costs of maintenance there should be easily obtainable.

"Much work is being done in the cities and to some extent in the country of the type known as 'asphaltic concrete'. This pavement in its original form was patented and is often called 'bitulithic'. With a hard, unyielding base a thickness of four inches may be used with good results, but unless the subgrade is nearly perfect, the upper surface of the road is likely to become wavy under the traffic. This sort of pavement costs from twelve to sixteen cents per square foot, $12,500 to $17,000 per mile, twenty feet wide, for the pavement alone. About twenty miles of such pavement was put down several years ago in San Joaquin County of an average width of eleven feet. I am told that, including the grading, this work cost about $11,000 per mile.

"In Alameda County, in the vicinity of Dublin, at the present time a road of this general type is being built at a cost of about $30,000 per mile, including the grading, the pavement being, if my information is correct, thirty feet in width.

"My personal preference is for a concrete base with an asphaltic concrete top from one and one half to two inches thick rather than for the full thickness of asphaltic concrete.

"I am sorry that this letter is so long; but explanations seemed necessary. To answer your questions categorically is nearly impossible, but

in my judgment a 'first class all-the-year-round highway' can be constructed to stand the mixed traffic on our county highways and continue of durable character at a reasonable cost for upkeep but I question if the cost can be kept below $300 per mile per annum on a twenty-foot roadway.

"Such a road as before discussed with a concrete base four inches thick and twenty feet wide covered with the thin coat of asphaltic oil and screenings will probably cost under your conditions not less than $9,000 per mile for the pavement alone."

Concrete Bases

By J. B. Woodson,
Division Engineer, California Highway Commission.

The four-inch base of Portland cement concrete, consisting of a proper mixture of one, two and one half, and five, if constructed upon a perfectly prepared subgrade, should afford sufficient strength to carry all traffic and any type of road vehicle now existing.

Except in alkali, quicksand or marsh-land soil, the four-inch thickness is as good as a foot, so far as sustaining qualities are concerned. Through unstable soil sections the pavement should be increased in thickness according to the degree of firmness of subgrade.

Some soils make a firm subgrade, but warrant extra thickness of pavement.

For example, adobe makes the hardest kind of subgrade if the clods are pulverized, but "wet streaks" in an adobe fill would, upon evaporation, have a tendency to settle locally; this in effect would require greater spanning power, which virtually means a heavier beam.

Under the heading of adobe should be classified alkali and dry bog. This latter, when thoroughly dry, resembles volcanic ash and the difference in its displacement under dry compression and when it is wet and heavy would produce an appreciable stress up under the pavement. All forms of adobe, however, have the cracking qualities in the dry season, and it is doubtful whether the extra thickness of concrete would prevent the cracks breaking through the pavement above.

Pavement construction on a low grade line, over marsh-land or wet sandy soil should be augmented by increased thickness of concrete.

Concrete for four-inch pavement should be mushy, but not "sloppy." It should be dry enough to require considerable tamping before it looks wet on top.

When the mixture flows out on the chute as if under pressure resembling a fire hydrant, the work should be stopped until the water feed can be adjusted. Some contractors claim that with a certain type of mixer the concrete will not discharge down the chute unless the mixture is very wet. This is a mistake, and when the water runs down the pavement in little rivulets floating away from the mortar, it won't be long under traffic until the rocks begin to break loose. The concrete should be tamped until the individual rocks disappear in the mortar, and the final floating should leave the pavement smooth and true to section. The floating is done with a wooden float, and from twenty to fifty feet in the rear of the placing of concrete. Some men soon become skilled in making a good finish.

A ten-ton roller is used in preparing the subgrade to shape. Sufficient rolling is done to compact the rough-grade firmly. The rough-grade is left from one half to one inch high for compression.

When finished, the subgrade is theoretically parallel and four inches lower than the desired elevation of pavement. The section drops three eighths of an inch per lineal foot each side of the crown, the bottom of header board being two and three fourths inches lower than the crown.

When the concrete is sufficiently set, which varies according to the weather from six to twelve hours, two to four inches of loose dirt is thrown over the pavement and is kept wet for a period of six days, and on later contracts ten days. During the hot weather, great care should be exercised in seeing that the concrete is moist under the covering of earth. A more satisfactory method of curing the concrete is by building little dykes about twenty feet apart and along the edge of the pavement, and flooding the concrete twice a day, or oftener if needed. This latter method always shows if the concrete is wet, is cheaper for the contractor, and is much more easily cleaned off.

Cleaning off the pavement is usually done with a road grader; the dirt being thrown out on the shoulders, again shaped, and rolled.

An approximate cost, as shown by our records, of covering with dirt is 2.5 cents per lineal foot, or 13.4 cents per cubic yard of concrete. The cost of dyking with dirt is 1.25 cents per lineal foot, or 6.75 cents per cubic yard of concrete.

When all the dirt is taken off that can be removed with the road grader, horse brooms are run over a pavement. If the dirt still remains in patches, shovels and stable brooms are applied.

The natural transverse cracks appear about twenty-eight feet apart. This varies considerably, according to the materials used and the care in keeping the concrete wet. With all forms of cracking that have developed so far no serious trouble is noticeable in wearing of concrete or appearances, and the bituminous wearing surface enters the crevices and covers them until they are scarcely perceptible.

Artificial construction joints do not seem to warrant the expense attached to them in the construction of concrete pavements in California. Where they have been used by means of redwood strips placed between strips of tar paper, the joint wears away under traffic and the regular crack appears at its natural interval. The cost of steel expansion joints is practically prohibitive for the benefit derived, and they do not eliminate the cracks. Steel reinforcing is not desirable for

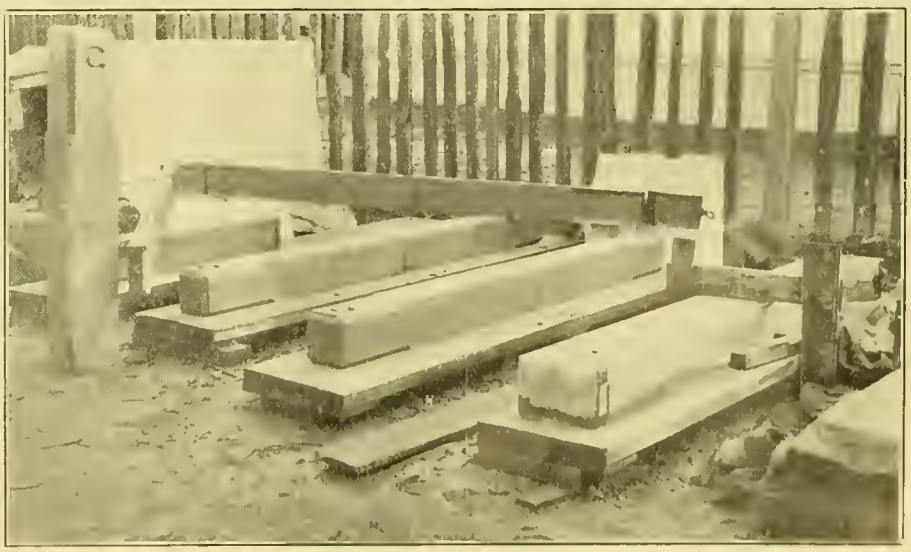
(Continued on page 14.)

MONUMENTS MAKE PERMANENT STATE HIGHWAY BOUNDARIES

Much difficulty is frequently experienced in determinating the location of the side lines of roads. These roads have been laid out in the past when the land was of little value and the surveys were carelessly made or the descriptions carelessly recorded. With the lapse of time buildings, trees, and other similar features, which formerly marked the location of the road, have entirely disappeared, and the traveled ways have shifted from place to place as the action of the elements or the whims of the travelers have directed. Fences, if they exist, have been so moved about that they in no way indicate the original line of the road.

To guard against a similar condition on the state highways, the California Highway Commission not only makes very careful surveys and plans and files said plans in several localities, but it also places monuments on the side lines of the roads at each and every angle or curve point, and at intervals on long straight lines.

The monuments project six inches above the surface of the ground. They are made of concrete six inches square and three and one half feet long. The edges of the upper portion are beveled to present a neat appearance, and on one face there is indented a letter "C" for the purpose of identification. In the center of the top is a copper plug which marks the exact point of the angle.



Monuments for California State Highway

pavements, owing to the expense. It would seem more practical to increase the thickness of pavement over sections of doubtful subgrade.

Out of five days' run on a contract near Fresno, at an average of 762 lineal feet of fifteen-foot pavement, the following force was used:

Foreman, 5 days at $4.00	$20 00
Labor, 5 days at $3.50	17 50
Labor, 6 days at $2.50	15 00
Labor, 132½ days at $2.00	265 00
Wagon and driver, 5 days at $4.50	22 50
Concrete mixer, fuel, etc., 5 days at $5.00	25 00
Water pump and engineer, 5 days at $6.00	30 00
Total	$395 00

Total length of run, 3,808 lineal feet, or 705 cubic yards of concrete; 56 cents per cubic yard.

On a cubic yard basis the cement cost $2.17, the stone cost 71 cents, and the sand cost 43 cents.

The average cost of unloading and transportation of material was 68 cents.

The total cost per cubic yard of concrete in place was $4.55.

Costs of Concrete Bases 15 Feet Wide at Various Prices Per Cubic Yard.

	Depths.	Cubic yards per mile.	Cost per mile.	Cost per square foot.	Cost per square yard.
$5.00 per cubic yard	4 in.	978	$4,890	$0.062	$0.556
	4½ in.	1,100	5,500	.069	.625
	5 in.	1,222	6,110	.077	.694
	5½ in.	1,344	6,720	.085	.764
	6 in.	1,467	7,333	.093	.833
$5.25 per cubic yard	4 in.	978	5,135	.065	.584
	4½ in.	1,100	6,775	.073	.656
	5 in.	1,222	6,416	.081	.729
	5½ in.	1,344	7,056	.089	.802
	6 in.	1,467	7,700	.097	.875
$5.50 per cubic yard	4 in.	978	6,379	.038	.611
	4½ in.	1,100	6,050	.076	.687
	5 in.	1,222	6,721	.085	.764
	5½ in.	1,344	7,392	.093	.840
	6 in.	1,467	8,066	.102	.917
$5.75 per cubic yard	4 in.	978	5,624	.071	.639
	4½ in.	1,100	6,325	.080	.719
	6 in.	1,222	7,027	.089	.799
	5½ in.	1,344	7,728	.098	.878
	6 in.	1,467	8,433	.106	.958
$6.00 per cubic yard	4 in.	978	5,868	.074	.667
	4½ in.	1,100	6,600	.083	.750
	5 in.	1,222	7,332	.093	.833
	5½ in.	1,344	8.064	.102	.916
	6 in.	1,467	8,800	.111	1.000
$6.25 per cubic yard	4 in.	978	6,113	.077	.695
	4½ in.	1,100	6,875	.087	.781
	5 in.	1,222	7,637	.096	.868
	5½ in.	1,344	8,400	.106	.955
	6 in.	1,467	9,166	.115	1.042
$6.50 per cubic yard	4 in.	978	6,357	.080	.722
	4½ in.	1,100	7,150	.090	.812
	5 in.	1,222	7,943	.100	.903
	5½ in.	1,344	8,736	.110	.993
	6 in.	1,467	9,533	.120	1.083

Costs of 15-foot Pavements.
(79,200 sq. ft. to mile.)
(8,800 sq. yds. to mile.)

Per square foot.	Per square yard.	Per mile.	Per square foot.	Per square yard.	Per mile.
$0.001	$0.009	$79 20	.115	1.035	9,108 00
.002	.018	158 40	.120	1.080	9,504 00
.003	.027	237 60	.125	1.125	9,900 00
.004	.036	316 80	.130	1.170	10,296 00
.005	.045	396 00	.135	1.215	10,692 00
.006	.054	475 20	.140	1.260	11,088 00
.007	.063	554 40	.145	1.305	11,484 00
.008	.072	633 60	.150	1.350	11,880 00
.009	.081	712 80	.155	1.395	12,276 00
.010	.090	792 00	.160	1.440	12,672 00
.020	.180	1,584 00	.165	1.485	13,068 00
.030	.270	2,376 00	.170	1.530	13,464 00
.040	.360	3,168 00	.175	1.575	13,860 00
.050	.450	3,960 00	.180	1.620	14,256 00
.060	.540	4,752 00	.185	1.665	14,652 00
.070	.630	5,544 00	.190	1.710	15,048 00
.080	.720	6,336 00	.195	1.755	15,444 00
.090	.810	7,128 00	.200	1.800	15,840 00
.100	.900	7,920 00			
.105	.945	8,316 00			
.110	.990	8,712 00			

Workmen's Modern Camp

Especial pains is taken in the construction camps, where work on a day labor basis is necessary on the part of the State, to provide comfortable and sanitary accommodations for the workmen. The camp at Shingle Springs, El Dorado County, is an example. Here the workmen

Meal Tent at Shingle Springs Camp.

have been provided large, airy tents, which are kept scrupulously clean. The dining-room is made clean and attractive, a wholesome variety of well-cooked food is served in abundance, and the flies are excluded carefully. Bathing facilities are provided for the use of the men.

Workmen's Tents at Shingle Springs Camp.

Manure is hauled away from the corral tent three times a week. A sanitary engineer was sent to Shingle Springs by the Commission of Housing and Sanitation, and with his cooperation all pains were taken to make this camp a model for the comfort and health of the workers.

Grades of Mountain Highways

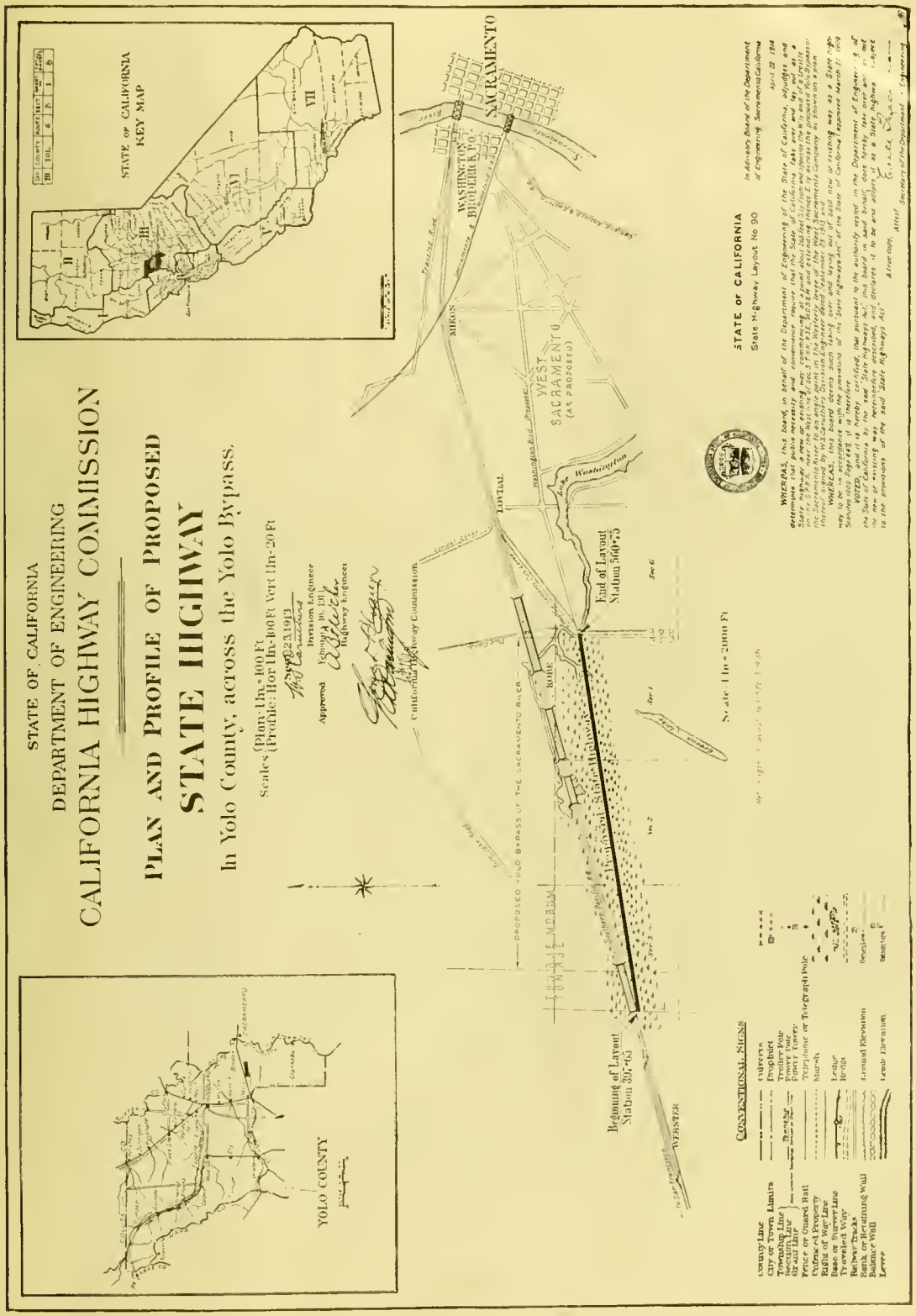
"The maximum grade for a mountain highway," said Division Engineer F. G. Somner, in discussing that subject before the department heads of the Highway Commission, "should be established with reference to the kind and volume of traffic; the existing transportation facilities, and the topography of the country traversed. The effect of steep grades on the cost of transportation is always an important consideration. A discussion of the loss of energy, traction resistance, etc., in connection with grade reduction is unnecessary, being always undisputed, but nevertheless, the questions always arise: Will it pay? How much will it cost? Whether horse-drawn vehicles or motor vehicles predominate?

"In the writer's opinion it does not pay to exceed a 6 per cent grade, which is a trotting grade for a buggy team, and accommodates any of the gears of the average automobile.

"As a rule, the establishment of a minimum grade on mountain highways is unnecessary for the reason that the culverts are generally placed at such short intervals as to admit of surface drainage even on a level grade. It may be considered impracticable to maintain unbroken grade lines, such refinement affecting economy of quantity and engineering cost."

PREPARING STATE HIGHWAY PLANS

The data turned in by the surveyors include location notes of all structures, tracks, trees, poles, and other similar objects, within one hundred and fifty feet of the base line; cross-section notes of the road taken at intervals of fifty feet or less; computations of a traverse, one side of which is the base line of the survey; and notes as to soil, drainage, location of desirable materials, railroad sidings, local wages, etc. So far as may be these notes are computed and checked before they leave the field.



On receipt of the notes in the division office the plan and profile are plotted on thirty-inch brown detail paper of such lengths as are convenient for flat filing when folded, and the cross-sections are plotted on specially prepared cross-section paper. This specially prepared cross-section paper is of map bond, 20-inch by 30-incb sheets, printed in orange ink from a "zinco" engraving with co-ordinate lines one tentb of an incb apart. At one end the margin reserved is wider for the purpose of binding.

The Contract Plans.

The contract plans are blue prints from the layout plans and from the cross-section sheets, but for tbe convenience of the engineering force pocket size photographic reductions of the layout plans are made also. Tbese photographic reductions are 4¼ inches by 7½ inches in size, and are printed on glossy velox paper. Tbey are remarkably legible, even witbout the use of a reading glass.

The layout plans, contract plans, and cross-section sheets are all bound in temporary binders for their protection and preservation. Tbese binders are composed of two heavy covers hinged by cloth to metal strips, and five bolts for clamping together the metal strips and the intervening plans.

Plans, Etc., Are Carefully Bound.

The binders are canvass and leather finisbed, and the back or lower cover is sufficiently long to permit of the steel binding strip being folded in between the plans and the cover, thereby concealing tbe bolt heads and insuring a non-scratching lower surface. The nut used is a brass, round-headed one, witb a threaded sleeve projecting one half inch through tbe top binding strip, and the screws are stove bolts of tbe many varying lengths. Great elasticity is obtained by this combination. Binders of similar design, but of lighter weight and clamped with paper fasteners, are used for the "form" papers, etc. Tbey are of two sizes, letter size and note size.

The Filing System.

The basis of most of tbe filing is the road location, wbether the filing be of plans, field books, papers, letters, or somctbing clse. The State has been divided into seven divisions, each of which is designated by a roman numeral. Each of the trunk lines or routes as determined is given an arabic number, and within each county these routes are divided into convenient contract lengths and lettered. The division number, county abbreviation, route number, and section letter are entered on all plans and papers, and they are filed according to tbis entry.

Progress on the State Highway

The following details are complete regarding awards of contracts to July 1, 1914, with one or two exceptions, as noted, and are complete regarding percentage of work done to May 15, 1914, the date of the last progress reports from the various divisions prior to going to press with this issue:

Routes under way are located in the counties as follows, the figures in parentheses indicating the divisions: Alameda, Division IV) route 5; Alpine (III); Butte, (III) 3 and 21; Calaveras, (III); Colusa, (III) 7 and 15; Contra Costa, (IV) 14; Del Norte, (I) 1; El Dorado, (III) 11; Fresno, (VI) 4; Glenn, (III) 7; Humboldt, (I) 1; Imperial, (VII) 12; Inyo, (VI); Kern, (VI) 4; Kings, (VI) 10; Lake (I) 16; Lassen, (II); Los Angeles, (VII) 2, 4 and 8; Madera, (VI) 4; Marin, (IV) 1; Mariposa, (VI) 18; Mendocino, (I) 1 and 16; Merced, (VI) 4 and 18; Modoc, (I); Mono, (VI): Monterey, (V) 2; Napa, (I /); Nevada, (III) 17; Orange, (VII) 2; Placer, (III) 3 and 17; Plumas, (III); Riverside, (VII) 19; Sacramento, (III) 3, 4 and 11; San Benito, (V) 2; San Bernardino, (VII) 8, 9 and 19; San Diego, (VII) 2 and 12; San Francisco, (IV) touched by 2 and within ferry reach of 1, 5, 7 and 14; San Joaquin, (III) 4 and 5; San Luis Obispo, (V) 2; San Mateo, (IV) 2; Santa Barbara, (V) 2; Santa Clara, (IV) 2 and 5; Santa Cruz, (IV) 5; Shasta, (II) 3 and 20; Sierra, (III); Siskiyou, (II) 3; Solano, (III) 7; Sonoma, (IV) 1; Stanislaus, (III) 4 and 13; Sutter, (III) 3; Tehama, (II) 3 and 7; Trinity, (II) 20; Tulare, (VI) 4 and 10; Tuolumne, (III) 13; Ventura, (VII) 2; Yolo, (III) 6 and 7; Yuba, (III) 3.

ROUTE 1. BETWEEN SAUSALITO AND CRESCENT CITY.

Marin County, Section A, from the north boundary of Marin County to the west boundary of San Rafael (IV—Mrn.—1–A): Surveys complete. Plans in progress. Length, 16.8 miles.

Marin County, Section B, from the west boundary of San Rafael to the ferry slip at Sausalito (IV—Mrn.—1–B): Laid out as State Highway May 27, 1914. Contract (No. 65) awarded May 27, 1914, to O'Brien Brothers. Length, 6 miles. Road to be graded and part surfaced with gravel. Probable cost, $66,365; probable cost per mile, $11,060.

Sonoma County, Section A, from the north boundary of Sonoma County to the south boundary of Healdsburg (IV—Son.—1–A): Laid out as State Highway April 22, 1914. Contract (No. 68) awarded May 27, 1914, to Hard Brothers. Length, 4.45 miles. Road to be graded 21 feet wide. Probable total cost, $43,550; per mile, $9,790.

Sonoma County, Section B, from the south boundary of Healdsburg to the south boundary of Santa Rosa (IV—Son.—1–B): Laid out as State Highway September 25, 1912. Contract (No. 16) awarded Oct. 22, 1912, to Richard Keatinge & Sons. Length, 13.7 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $108,761; per mile, $7,939. Amount of contract complete May 16, 1914, 84 per cent.

Sonoma County, Section C, from the south boundary of Santa Rosa to the south boundary of Sonoma County (IV—Son.—1–C): Surveys completed. Plans in progress. Length, 18.7 miles.

Mendocino County, Section A, from the south boundary of Mendocino County to Hopland (I—Men.—1–A): Laid out as State Highway May 21, 1912. Contract (No. 2) awarded July 23, 1912, to the General Contracting Corporation. Length, 13.2 miles. Road graded 18 feet wide, but not paved. Probable total cost, $66,540; per mile, $5,040. Contract completed.

Mendocino County, Section B, from Hopland to Ukiah (I—Men.—1–B): Survey and plans completed. Length, 14 miles.

Mendocino County, Section C, from Ukiah to Forsythe Creek (1—Men.—1–C): Laid out as State Highway February 4, 1913. Contract (No. 24) awarded March 26, 1913, to D. L. Sawyers and Chas. Whited. Length, 7.6 miles. Road to be waterbound macadam and gravel, 15 feet wide. Probable total cost, $55,651; per mile, $7,288. Contract practically completed.

Mendocino County, Section D, from Forsythe Creek to Ridgewood (I—Men.—1–D): Surveys completed. Length, 7.9 miles.

Contract D_1, Laid out as State Highway September 24, 1913. Length, 7.8 miles. Road to be graded 18 feet wide, but not paved. No. D_1, 1.25 miles of this layout graded by day labor; work completed.

Contract D_2, Laid out as State Highway September 24, 1913. Contract (No. 57) awarded April 22, 1914, to Hard Brothers. Length, 6.6 miles. Road to be graded 18 feet wide. Probable total cost, $57,802; per mile, $8,825.

Mendocino County, Section E, from Ridgewood to Willits (I—Men.—1–E): Laid out as State Highway October 22, 1912. Contract (No. 20) awarded February 4, 1913, to Fairbanks & Baechtel. Length, 6.9 miles. Road graded 18 feet wide. Probable total cost, $38,855; per mile, $5,630. Contract completed.

Mendocino County, Section F, from Willits to Arnold (I—Men.—1–F): Surveys and plans completed. Length, 8.5 miles.

Mendocino County, Section G, from Arnold to Sherwood-Laytonville Junction (I—Men—1–G): Surveys and plans completed. Length, 10.4 miles.

Mendocino County, Section H, from Sherwood-Laytonville Junction to Rattlesnake Summit (I—Men.—1–H): Surveys and plans completed. Length 14.2 miles.

Mendocino County, Section I, from Rattlesnake Summit to Little Dan Valley (I—Men.—1–I): Surveys and plans completed. Length, 13.6 miles.

Mendocino County, Section J, from Little Dan Valley to Low Gap (I—Men.—1–J): Surveys completed. Plans in progress. Length, 10.5 miles.

Mendocino County, Section K, from Low Gap to the north boundary of Mendocino County (I—Men.—1–K): Surveys completed. Length, 13 miles.

Humboldt County, Section A, from the south boundary to Garberville (I—Hum.—1–A): Survey completed. Length, 10.3 miles.

A_1. Laid out as State Highway September 24, 1913. Contract (No. 44) awarded Oct. 29, 1913, to Fairbanks & Baechtel. Length, 5.5 miles. Road to be graded 18 feet wide. Probable total cost, $56,360; per mile, $10,266. Amount of contract completed May 16, 1914, 4 per cent.

A_2. Laid out as State Highway March 25, 1914. Contract (No. 60) awarded April 22, 1914, to Berry, Mackie & Co. Length, 4.6 miles. Road to be graded 18 feet wide. Probable total cost, $52,535; per mile, $11,470.

Humboldt County, Section B, from Garberville to Miranda (I—Hum.—1–B): Surveys completed. Plans in progress. Length, 16.1 miles.

Humboldt County, Section C, from Miranda to Dyerville (I—Hum.—1–C): Surveys completed. Plans in progress. Length, 13.9 miles.

Humboldt County, Section D, from Dyerville to opposite Elinor (I—Hum.—1–D): Survey completed. Length, 11.3 miles.

D_1, Laid out as State Highway May 27, 1914. Contract (No. 71) awarded June 10, 1914, to Smith & Conners, Length, 7.3 miles. Road to be graded 18 feet wide. Probable total cost, $47,690; per mile, $6,530.

Humboldt County, Section E, from opposite Elinor to Rio Dell (I—Hum.—1–E): Surveys completed. Plans in progress. Length, 10 miles.

Humboldt County, Section F, from Rio Dell to Fortuna (I—Hum.—1–F): Survey completed. Length, 11 miles.

Humboldt County, Section G, from Fortuna to Eureka (I—Hum.—1–G): Survey completed. Length, 17 miles.

Humboldt County, Section H, I, J and K, north from Eureka. Surveys ordered.

Del Norte County, Section A, from south boundary of Del Norte County to Crescent City (I—D. N.—1–A): Survey ordered.

ROUTE 2. BETWEEN SAN FRANCISCO AND SAN DIEGO.

San Mateo County, Section A, from the north boundary of San Mateo County to San Mateo City (IV—S. M.—2–A): Survey completed. Length, 10.7 miles.

Contract A_1, from South San Francisco to Burlingame: Laid out as State Highway May 21, 1912. Contract (No. 1) awarded July 23, 1912, to F. R. Ritchie & Co. Length, 5.4 miles. Sheet asphalt 24 feet wide on concrete base. Probable total cost, $93,004; per mile, $17,223. Contract completed.

Contract A_2, from Burlingame to Hillsborough: Laid out as State Higbway October 22, 1912. Contract (No. 29) awarded April 23, 1913, to Clark & Henery Construction Co. Length, 0.2 mile. Road 24 feet wide. Asphaltic concrete on Portland cement concrete base. Probable cost, $5,637; per mile $28,184. Contract completed.

Contract A_3, north boundary of San Mateo County to south line of Daly City: Laid out as State Highway March 26, 1913. Contract (No. 26) awarded April 23, 1913, to Flinn & Treacy. Length, 1.02 miles. Road 24 feet wide. Asphaltic concrete on Portland cement concrete base. Probable total cost, $20,303; per mile, $19,866. Amount of contract completed May 16, 1914, 85 per cent.

Contract A_4, Cypress Lawn Cemetery to South San Francisco: Laid out as State Highway May 21, 1913. Contract (No. 34) awarded July 3, 1913, to Mahony Brothers. Length, 2.1 miles. Road to be graded 40 feet wide, for future pavement of 24 feet width. Probable total cost of grading, $27,847; per mile, $13,260. Contract completed.

Contract A_5, south line of Daly City to South San Francisco: Laid out as State Highway February 26, 1914. Contract (No. 54) awarded Feb. 26, 1914, to Bates, Borland & Ayer. Length, 4.0 miles. Road to be asphalt surface on concrete base, 24 feet wide. Probable total cost, $85,813; per mile, $21,220. Amount of contract completed to May 16, 1914, 1 per cent.

San Mateo County, Section B, from San Mateo City to the south boundary of San Mateo County (IV—S.M.—2—B): Surveys and plans completed. Length, 9.4 miles.

Contract B_1, Redwood City to south boundary of county: Laid out as State Highway Oct. 22, 1912. Contract (No. 22) awarded March 26, 1913, to S. P. Doyle. Length, 3.3 miles. Road to be asphaltic concrete on macadam base, 20 feet wide. Probable total cost, $50,990; per mile, $15,450. Contract completed.

Contract B_2, San Mateo to Beresford: Laid out as State Highway March 26, 1913. Contract (No. 27) awarded April 23, 1913, to Raisch Improvement Co. Length, 1.8 miles. Road to be asphaltic concrete on macadam base, 20 feet wide. Probable total cost, $28,245; per mile, $15,690. Contract completed.

Santa Clara County, Section A, from the north boundary of Santa Clara County to San Jose (IV—S.Cl.—2–A): Surveys and plans complete. Length, 15.1 miles.

Contract A_1, Palo Alto to Stevens Creek bridge: Laid out as State Highway July 23, 1912. Contract (No. 14) awarded Oct. 22, 1912, to City Street Improvement Co. Length, 6.4 miles. Road to be asphaltic concrete on macadam base, 20 feet wide. Probable total cost, $43,274; per mile, $6,726. Amount of contract completed to May 16, 1914, 100 per cent, but not fully paid.

Contract A_2, Stevens Creek bridge to Saratoga-Lawrence road: Laid out as State Highway July 23, 1912. Contract (No. 15) awarded Oct. 22, 1912, to A. Teichert & Son. Length, 5.5 miles. Pavement, oiled concrete, 20 feet wide. Probable total cost, $54,294; per mile, $9,854. Contract completed.

Contract A_3, Saratoga-Lawrence road to Santa Clara: Laid out as State Highway April 23, 1913. Contract (No. 32) awarded May 21, 1913, to John Doyle. Length, 1.2 miles. Pavement, oiled concrete, 20 feet wide, with broken stone shoulders 5 feet wide. Probable total cost, $15,168; per mile, $13,190. Contract completed.

Santa Clara County, Section B, from San Jose to Morgan Hill (IV—S. Cl.—2–B): Survey and plans completed. Length, 17.3 miles.

Contract B_1, Edenvale to Morgan Hill: Laid out as State Highway Oct. 22, 1912. Contract (No. 23) awarded March 26, 1913, to Richard Keatinge & Sons. Length, 13.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $87,880; per mile, $6,786. Amount of contract completed May 16, 1914, 100 per cent, but not fully paid.

Contract B_2, San Jose to Edenvale: Laid out as State Highway March 26, 1913. Contract (No. 28) awarded April 23, 1913, to Richard Keatinge & Sons. Length, 4.3 miles. Pavement, oiled concrete, 15 to 20 feet wide. Probable total cost, $32,397; per mile, $7,451. Amount of contract completed to May 16, 1914, 100 per cent, but not fully paid.

Contract B_3, San Jose to Mulia: Laid out as State Higbway March 26, 1913. Contract (no. 64) awarded April 22, 1914, to John W. McDonald, Jr. Length, 1.8 miles. Asphalt surfacing on portion of Contract No. 28. Probable total cost, $13,820; per mile, $7,510.

Santa Clara County, Section C, from Morgan Hill to south boundary of Santa Clara County (IV—S. Cl.—2–C): Survey complete. Length, 13.9 miles.

Contract C_1, Morgan Hill to Gilroy: Laid out as State Highway May 21, 1913. Contract (No. 35) awarded July 3, 1913, to E. O. Burge. Length, 7.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $50,801; per mile, $6,693. Amount of contract completed to May 16, 1914, 59 per cent.

Contract C_2, Gilroy to Sargent: Laid out as State Highway May 27, 1914. Contract (No. 72) awarded June 10, 1914, to H. L. Petersen and A. J. Grier. Length, 6.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $67,720; per mile, $11,287.

San Benito County, Section A, from the north boundary to the southwest boundary of San Benito County through San Juan Bautista (V—S. Bt.—2–A): Survey completed. Length, 9.2 miles.

Contract A_1, Laid out as State Highway Aug. 27, 1913. Contract (No. 42) awarded Oct. 29, 1913, to E. O. Burge. Length, 4.2 miles. Road to be graded 21 feet wide, not paved. Probable total cost, $27,647; per mile, $6,551. Amount of contract completed May 16, 1914, 26 per cent.

Contract A_2, from San Juan Bautista to the northern boundary. Length, about 4.0 miles. Bids will be received July 6, 1914, for construction of Portland cement concrete.

Monterey County, Section A, from the northeast boundary of Monterey County to Salinas (V—Mon. 2–A): Length, 10.45 miles.

Contract A_1 Laid out as State Highway August 27, 1913. Contract (No. 41) awarded October 29, 1913, to E. O. Burge. Length, 4.3 miles. Road to be graded, 21 feet wide, not paved. Probable total cost, $30,828; per mile, $7,103. Amount of contract completed to May 16, 1914, 67 per cent.

Monterey County, Section B, from Salinas to a point 1,800 feet south of Chualar (V—Mon.—2–B): Surveys, plans and estimates complete. Length 10.3 miles.

Monterey County, Section C, from a point 1,800 feet south of Cbualar to Camphora (V—Mon.—2–C): Surveys complete. Plans in progress. Length, 11.0 miles.

Monterey County, Section D, from Camphora to Greenfield (V—Mon.—2-D); Surveys completed. Plans in progress. Length, 12.2 miles.

Monterey County, Section E, from Greenfield to a point 4 miles north of King City (V—Mon.—2-E): Laid out as State Highway October 22, 1912. Length, 7.3 miles. Pavement, oiled concrete, 15 feet wide.

Monterey County, Section F, from a point 4 miles north of King City to San Lucas (V—Mon.—2-F): Surveys completed. Length, 12.7 miles.

Monterey County, Section G, from San Lucas to San Ardo (V—Mon.—2-G): Surveys completed. Plans under way. Length, 10.8 miles.

Monterey County, Section H, from San Ardo to a point 1½ miles north of Bradley (V—Mon.—2-H): Surveys, plans and estimates complete. Length, 11.0 miles.

Monterey County, Section I, from a point 1½ miles north of Bradley to the south boundary line of Monterey County (V—Mon.—2-I): Surveys completed. Plans under way. Length, 10.4 miles.

San Luis Obispo County, Section A, from the north boundary of San Luis Obispo County to Paso Robles (V—S. L. O.—2-A): Laid ont as State Highway October 29, 1913. Bids received Nov. 17, 1913; action thereon postponed. Contract (No. 56) awarded February 26, 1914, to W. A. Dontanville. Pavement, oiled concrete, 15 feet wide. Length, 10.6 miles. Probable total cost, $117,254; per mile, $11,060.

San Luis Obispo County, Section B, from Paso Robles to a point where Atascadero Creek crosses the Highway west of Atascadero Station (V—S. L. O.—2-B): Surveys completed. Plans in progress. Length, 10.1 miles.

San Luis Obispo County, Section C, from a point where Atascadero Creek crosses the Highway west of Atascadero Station to Santa Margarita (V—S. L. O.—2-C): Laid out as State Highway October 29, 1913. Bids received Nov. 17, 1913; action thereon postponed. Contract (No. 55) awarded Feb. 26, 1914, to W. A. Dontanville. Pavement, oiled concrete, 15 feet wide. Length, 8.4 miles. Probable total cost, $81,626; per mile, $9,780. Amount of contract completed to May 16, 1914, 24 per cent.

San Luis Obispo County, Section D, from Santa Margarita to San Luis Obispo (V—S. L. O.—2-D): Surveys, plans and estimates completed. Length, 10.0 miles.

Contract D_1, laid out as State Highway October 22, 1912. Bids received and rejected November 18, 1912. Bids received and rejected June 30, 1913. Work now under construction (No. D3) by the State, using day labor. Length, 6.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $63,972; per mile, $10,038. Amount completed to May 16, 1914, 90 per cent.

San Luis Obispo County, Section E, from San Luis Obispo to Arroyo Grande via Pismo (V—S.L.O.—2-E): Surveys completed. Plans in progress. Length, 14 5 miles. Bids will be received July 6, 1914, for construction of Portland cement concrete.

San Luis Obispo County, Section F, from Arroyo Grande to the south boundary line of San Luis Obispo County (V—S. L. O.—2-F): Surveys completed. Plans in progress. Length, 12 4.

Santa Barbara County, Section A, from the north boundary of Santa Barbara County to a point 1 mile north of Bicknell (V—S. B.—2-A): Surveys completed. Plans in progress. Length, 10.6 miles. Bids will be received July 6, 1914, for construction of Portland cement concrete with asphaltic wearing surface.

Santa Barbara County, Section B, from a point I mile north of Bicknell to Los Alamos (V—S. B.—2-B): Laid out as State Highway May 21, 1913. Contract (No. 36) awarded July 3, 1913, to Mayer & Lewis. Length, 11.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $125,808; per mile, $10,585. Amount of contract completed May 16, 1914, 30 per cent.

Santa Barbara County, Section C, from Los Alamos to Zaca Station (V—S. B.—2-C): Surveys completed. Plans in progress. Length 8.5 miles.

Santa Barbara County, Section D, from Zaca Station to Gaviota Pass (V—S. B.—2-D): Surveys completed. Length, 11.8 miles.

Santa Barbara County, Section E, from Gaviota Pass to Alcatraz school house (V—S. B.—2-E): Surveys completed. Plans in progress. Length, 8.3 miles.

Santa Barbara County, Section F, from Alcatraz schoolhouse to El Capitan crossing (V—S.B.—2-F): Surveys complete. Plans in progress. Length, 10.4 miles.

Santa Barbara County, Section G, from El Capitan crossing to Stony Creek (V—S. B.—2-G): Surveys completed. Plans in progress. Length, 9.4 miles.

Santa Barbara County, Section H, from Carpinteria to the south boundary of Santa Barbara County (V—S. B.—2-H): Laid out as State Highway Octoher 29, 1913. Contract (No. 45) awarded November 21, 1913, to Occidental Construction Co. Length, 2.4 miles. Grading 15 feet wide for 0.9 mile; remainder, pavement, oiled concrete, 15 feet wide. Probable total cost, $17,340; per mile, $7,379. Contract completed.

Santa Barbara County, Section I, from Stony Creek to Glen Anne canyon road (V—S. B.—2-I): Surveys, plans and estimates completed. Length, .8 mile.

Ventura County, Section A, from Ventura-Los Angeles county line to Newbury Park (VII—Ven.—2-A): Laid out as State Highway March 26, 1913. Bids received and rejected April 21, 1913. Bids received May 19, 1913. Contract (No. 31) awarded May 21, 1913, to Leigh G. Garnsey. Length, 7.3 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $71,526; per mile, $9,739. Amount of contract completed May 16, 1914, 99 per cent.

Ventura County, Section B, from Newbury Park to Springville (VII—Ven.—2-B): Surveys, plans and estimates completed. Length, 11.2 miles. Bids will be received July 6, 1914, for construction of Portland cement concrete.

Ventura County, Section C, from Springville to Ventura (VII—Ven.—2-C): Surveys completed. Plans in progress. Length, 10.2 miles.

Ventura County, Sections D, from Ventura to Padre Juan canyon, and E, from Padre Juan canyon to Sea Cliff (VII—Ven.—2-D-E): Laid out as State Highway January 21, 1914. Contract (No. 52) awarded February 26, 1914, to Carl Leonardt. Length, 8.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $109,644; per mile, $13,670. Amount of contract complete May 16, 1914, 1 per cent.

Ventura County, Section F, from Sea Cliff to Rancho El Rincon (VII—Ven.—2-F): Laid out as State Highway August 27, 1912. Length, 4 4 miles. This section includes a long timber trestle which was taken over by the State. See Section G.

Ventura County, Section G, from Rancho El Rincon to the Ventura-Santa Barbara county line (VII—Ven.—2-G): Laid out as State Highway March 25, 1914. Contract (No. 73) awarded for Sections F and G June 10, 1914, to Modern Construction Co. Length, 5.0 miles. Pavement, 15 feet, oiled concrete, not including the trestle. Probable total cost, $52,860; per mile, $10,572.

Ventura County, Section H, alternate route from foot of Conejo grade to Oxnard, length 10.1 miles; and Section I, alternate route from Oxnard to El Rio, length 2.2 miles: Survey completed.

Los Angeles County, Section A, from County Highway No. 3 to Rancho El Encino (VII—L. A.—2-A): Laid out as State Highway Sept. 25, 1912. Contract (No. 17) awarded October 22, 1912, to Rogers Brothers Co. Length, 6.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $55,127; per mile, $8,353. Contract completed.

Los Angeles County, Section B, from Rancho El Encino to Calahasas (VII—L. A.—2-B): Laid out as State Highway February 4, 1913. Contract (No. 21) awarded March 4, 1913, to John D. Marsh. Length, 10.1 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $81,690; per mile, $8,063. Amount of contract completed May 16, 1914, 83 per cent.

Los Angeles County, Section C, from Calahasas to the Los Angeles-Ventura county line (VII—L. A.—2-C): Laid out as State Highway April 23, 1913. Contract (No. 33) awarded May 21, 1913, to Gillette, Montgomery & Tracy. Length, 11.3 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $133,291; per mile, $11,818. Amount of contract completed May 16, 1914, 70 per cent.

Remainder in Los Angeles County outside Los Angeles is County highway.

Orange County, Section A, from the Orange-San Diego county line to the Santa Fe crossing 4 miles north of San Juan Capistrano (VII—Ora.—2-A): Surveys completed. Plans in progress. Length, 15.4 miles.

Orange County, Section B, from the Santa Fe crossing 4 miles north of San Juan Capistrano to Irvine (VII—Ora—2-B): Surveys completed. Plans in progress. Length, 9.4 miles.

Orange County, Section C, from Irvine to Santa Ana (VII—Ora.—2-C): Surveys completed. Plans in progress. Length 7.6 miles.

Orange County, Section D, from Santa Ana to Anaheim (VII—Ora.—2-D): See Section F following.

Orange County, Section E, from Anaheim to Fullerton (VII—Ora—2-E): See Section F following.

Orange County, Section F, from Fullerton to the Orange-Los Angeles county line (VII—Ora.—2-F): Laid out as State Highway August 27, 1913. Contract (No. 40) awarded October 29, 1913, to Conner Contracting Co. Length, 11.2 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $86,902; per mile, $7,787. Amount of contract completed May 16, 1914, 64 per cent.

San Diego County, Section A, from the north city limits of San Diego to C street, Encinitas (VII—S. D.—2-A): Laid out as State Highway July 23, 1912. Contract (No. 7) awarded August 27, 1912, to M. L. Curtis & Co. Length, 8.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $69,157; per mile, $8,213. Contract completed.

San Diego County, Section B, from C street, Encinitas to the south city limits of Oceanside (VII—S. D.—2-B): Laid out as State Highway October 22, 1912. Contract (No. 30) awarded May 21, 1913, to J. M. Montgomery. Length, 10.5 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $82,187; per mile, $7,867. Amount of contract completed May 16, 1914, 98 per cent.

San Diego County, Section C, from the north city limits of Oceanside to the Santa Fe crossing 1 mile north of Las Flores station (VII—S. D.—2-C): Laid out as State Highway July 23, 1913. Contract (No. 39) awarded Sept. 24, 1913, to the C. L. Hyde Construction Co. Length, 8.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $67,774; per mile, $8,440. Amount of contract completed May 16, 1914, 92 per cent.

San Diego County, Section D, from the Santa Fe frossing 1 mile north of Las Flores station to the San-Diego-Orange County line (VII—S. D.—2-D): Laid out as State Highway February 26, 1914. Contract (No. 58) awarded April 22, 1914, to W. A. Perry. Length, 11.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $108,867; per mile, $9,393.

ROUTE 3. BETWEEN SACRAMENTO AND THE OREGON BOUNDARY LINE.

Sacramento County, Section A, from the Auburn road to the north boundary line of Sacramento County (III—Sac.—3-A): Laid out as State Highway August 27, 1912. Contract (No. 12) awarded Sept. 25, 1912, to Burns, Clark & De Roza. Length, 1.8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $15,057; per mile, $8,183. Contract completed.

Placer County, Section A, from the south boundary line of Placer County to Lincoln (III—Pla.—3-A): Laid out as State Highway Aug. 27, 1912. Contract (No. 13) awarded September 25, 1912, to Burns, Clark & De Roza. Length, 9.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $83,600; per mile, $8,427. Amount of contract completed May 16, 1914, 100 per cent, but not fully paid.

Placer County, Section B, from Lincoln to the Placer-Yuba county line (III—Pla.—3-B): Surveys, plans and estimates completed. Length, 9.4 miles.

Yuba County, Section A, from the south boundary line of Yuba County to Morrison's Crossing (III—Yuba—3-A): Surveys, plans and estimates completed. Length, 3.4 miles.

Yuba County, Section B, from Morrison's Crossing to Marysville (III—Yuba—3-B): Laid out as State Highway May 21, 1912. Contract (No. 4) awarded July 23, 1912, to F. E. Frey. Length, 9.2 miles. Pavement, oiled macadam, 15 feet wide. Probable total cost, $67,688; per mile, $7,341. Contract completed.

Sutter County, Section A, from Yuba City to the Sutter-Butte county line (III—Sut.—3-A): Survey and plans completed. Length, 11.7 miles.

Butte County, Section A, from the south county line of Butte County to Biggs (III—But.—3-A): Surveys completed. Length, 7.4 miles.

Butte County, Section B, from Biggs to Nelson (III—But. 3-B): Surveys completed. Length, 10.1 miles.

Butte County, Section C, from Nelson to Chico (III—But.—3-C): Surveys completed. Length, 12.5 miles.

Butte County, Section D, from Chico to the north boundary of Butte County (III—But.—3-D): Laid out as State Highway October 22, 1912. Bids received November 18, 1912. Contract (No. 70) awarded June 10, 1914, to P. L. Burr. Length, 11.2 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $109,690; per mile, $9,770.

Tehama County, Section A1, from the south boundary of Tehama County to Los Molinos (II—Teh.—3-A): Surveys, plans and estimates completed. Length, 10.6 miles. Bids to be received July 6, 1914, for construction of Portland cement concrete

Tehama County, Section B, from Tehama Junction to Red Bluff (II—Teh. 3-B): Surveys and plans in progress.

Tehama County, Section C, from Red Bluff to the North boundary of Tehama County (II—Teh.—3-C): Surveys, plans and estimates completed. Length 14 02 miles.

Shasta County, Section A, from the south boundary of Shasta County to Redding (II—Sha.—3-A): Surveys completed. Plans in progress. Length, 15.88 miles.

Shasta County, Section B, from Redding to Baird (II—Sha.—3-B): Surveys completed. Plans and estimates completed.

Shasta County, Section C, from Baird to Le Moine (II—Sha.—3-C): Surveys completed. Plans and estimates completed.

Bids will be received July 6 on 16.2 miles of Sections B and C, from Bayha to the Sacramento River, to be graded

Shasta County, Section D, from Le Moine to the north boundary of Shasta County (II—Sha.—3-D): Surveys completed. Length, 21.44 miles.

Contract D_1, from Le Moine to Hazel Creek: Laid out as State Highway

April 22, 1914. Contract (No. 75) awarded June 10, 1914, to F. Rolandi. Length, 9.9 miles. Road to be graded 18 feet wide. Probable total cost, $71,600; per mile, $7,210.

Plans and estimates on remaining portion of Section D are partially complete.

Siskiyou County, Section A, from the south boundary of Siskiyou County to Weed (II—Sis.—3–A): Surveys completed. Plans in progress. Length, 18.2 miles.

Siskiyou County, Section B, from Weed to Yreka (II—Sis.—3–B): Surveys completed. Plans in progress. Length, 28.46 miles.

Siskiyou County, Section C, from Yreka to the California-Oregon boundary line (II—Sis.—3–C): Surveys completed. Length, 25.35 miles.

Contract C_1, from Hornbrook to the California-Oregon boundary line: Laid out as State Highway April 22, 1914. Contract (No. 66) awarded May 27, 1914, to W. H. Mason and F. T. Fradenburgh. Length, 8.0 miles. Road to be graded, 18 feet wide. Probable total cost, $36,200; per mile, $4,510.

Plans and estimates on remaining portion of Section C are partially complete.

ROUTE 4. SACRAMENTO TO LOS ANGELES.

Sacramento County, built by the County.

San Joaquin County, built by the County.

Stanislaus County. Section A, from the south boundary of Stanislaus County to a point 1½ miles north of Ceres (III—Sta.—4–A): Laid out as State Highway July 23, 1912. Contract (No. 5) awarded Aug. 27, 1912, to E. O. Burge. Length, 12.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $89,429; per mile, $7,428. Contract completed.

Stanislaus County, Section B, from a point 1½ miles north of Ceres to the north boundary of Stanislaus County (III—Sta.—4–B): Laid out as State Highway March 4, 1913. Contract (No. 25) awarded March 26, 1913, to Considine & Bates Co. Length, 9.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $67,795; per mile, $7,077. Amount of contract completed May 16, 1914, 93 per cent.

Merced County, Section A, from the south boundary of Merced County to the city of Merced (VI—Mer.—4–A): Laid out as State Highway Oct. 22, 1912. Contract (No. 69) awarded May 27, 1914, to Taylor & Berliner. Length, 14.2 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $115,950; per mile, $8,170.

Section B has been combined with Section A.

Merced County, Section C, from Arena to Merced (VI—Mer.—4–C): Laid out as State Highway Aug. 27, 1912. Contract (No. 11) awarded Sept. 29, 1912, to the Worswick Street Paving Co. Length, 10.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $84,712; per mile, $7,798. Amount of contract completed to May 16, 1914, 85 per cent.

Merced County, Section D, from the north boundary of Merced County to Arena (VI—Mer.—4–D): Laid out as State Higbway July 23, 1912. Contract (No. 6) awarded Aug. 27, 1912, to the Worswick Street Paving Co. Length, 9.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $67,585; per mile, $7,025. Contract completed.

Madera County, Section A, from the south boundary of Madera County to the city of Madera (VI—Mad.—4–A): Laid out as State Highway July 23, 1912. Contract (No. 9) awarded Aug. 27, 1912, to the Worswick Street Paving Co. Length, 9.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $64,405; per mile, $6,473. Contract completed.

Madera County, Section B, from Madera to Califa (VI—Mad.—4–B): Laid out as a State Highway May 21, 1912. Contract (No. 3) awarded July 23, 1912, to the Ransome-Crummey Co. Length, 9.9 miles. Pavement, oiled macadam, 15 feet wide. Probable total cost $68,890; per mile, $6,952. Contract completed.

Madera County, Section C, from Califa to the north boundary of Madera County (VI—Mad.—4–C): Laid out as State Highway July 23, 1912. Contract (No. 10) awarded Aug. 27, 1912, to the Worswick Street Paving Co. Length, 6.8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $46,100; per mile, $6,753. Amount of contract completed to May 16, 1914, 36 per cent.

Fresno County, Section A, from the south boundary of Fresno County to Fowler (VI—Fre.—4–A): Laid out as State Highway Oct. 29, 1913. Contract (No. 48) awarded Nov. 21, 1913, to A. Teichert & Son. Length, 8.2 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $64,952; per mile, $7,915. Amount of contract completed to May 16, 1914, 31 per cent.

Fresno County, Section B, from Fowler to Fresno (VI—Fre.—4–B): Laid out as State Highway Oct. 29, 1913. Contract (No. 47) awarded Nov. 21, 1913, to A. Teichert & Son. Length, 8.0 miles. Pavement, oiled concrete, 20 feet wide. Probable total cost, $67,335; per mile, $8,423. Amount of contract completed May 16, 1914, 53 per cent.

Fresno County, Section C, from Fresno to the Fresno-Madera county line (VI—Fre.—4–C): Laid out as State Highway July 23, 1912. Contract (No. 8) awarded Aug. 27, 1912, to the Worswick Street Paving Co. Length, 9.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $67,546; per mile, $7,065. Contract completed.

Tulare County, Section A, from the south boundary of Tulare County to a point between Pixley and Tipton (VI—Tul.—4–A): Surveys completed and plans in progress. Length, 15.26 miles.

Tulare County, Section B, from a point between Pixley and Tipton to Tulare (VI—Tul.—4–B): Surveys completed and plans in progress. Length, 12.78 miles.

Tulare County, Section C, from Tulare to Goshen (VI—Tul.—4–C): Surveys, plans and estimates partially complete.

No Section D.

Tulare County, Section E, from Goshen to the north boundary line of Tulare County (VI—Tul.—4–E): Laid out as State Highway Jan. 21, 1914. Length, 13.76 miles.

Kern County, Section A, from the south boundary of Kern County northerly 10.7 miles (VI—Kern—4–A): Surveys, plans and estimates completed.

Kern County, Section B, from Grape Vine creek to Sections 5 and 6, T. 32 S., R. 28 E., M. D. B. and M. (VI—Ker.—4–B): Surveys, plans and estimates completed. Length, 17.29 miles. Bids will be received July 6, 1914, for construction of Portland cement concrete.

Kern County, Section C, from Sections 5 and 6, T. 32 S., R. 28 E., M. D. B. and M. to Bakersfield (VI—Kern—4–C): Laid out as State Highway May 27, 1914. Contract (No. 67) awarded May 27, 1914, to John D. Marsh. Length, 13.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $142,360; per mile, $10,970.

Kern County, Section D, from Bakersfield to Lerdo (VI—Kern—4–D): Laid out as State Highway Jan. 21, 1914. Contract (No. 50) awarded Feb. 26, 1914, to Geo. S. Benson & Sons. Length, 10.1 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $71,209; per mile, $7,026. Amount of contract completed May 16, 1914, 16 per cent.

Kern County, Section E, from Lerdo to Famosa (VI—Kern—4–E): Laid out as State Highway Jan. 21, 1914. Contract (No. 51) awarded Feb. 26, 1914, to Geo. S. Benson & Sons. Length, 8.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $56,720; per mile, $6,343.

Kern County, Section F, from Famosa to the north boundary of Kern County (VI—Kern—4–F): Laid out as State Highway March 12, 1914. Contract (No. 63) awarded April 22, 1914, to Lynn S. Atkinson. Length, 12.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $108,340; per mile, $8,710.

Los Angeles County, Section A, from Newball to Castaic schoolhouse (VII—L. A.—4–A): Surveys completed. Plans in progress. Length, 8.8 miles.

Los Angeles County, Section B, from Castaic school house to top of ridge (VII—L. A.—4–B): Surveys completed. Plans in progress. Length, 12.1 miles.

Los Angeles County, Section C, from top of ridge to Liebre Mountain (VII—L. A.—4–C): Surveys completed. Plans in progress. Length, 16.1 miles.

Los Angeles County, Section D, from Liebre Mountain to the Los Angeles-Kern county line (VII—L. A.—4–D): Laid out as State Highway May 27, 1914. Contract (No. 78) awarded June 10, 1914, to Lee Moor. Length, 12.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $201,920; per mile, $16,000.

ROUTE 5. BETWEEN THE SAN JOAQUIN VALLEY AND SANTA CRUZ VIA. SAN FRANCISCO BAY.

San Joaquin County—Built by the County.

Alameda County, Section A, from the east boundary of Alameda County to Livermore (IV—Ala.—5–A): Surveys completed. Plans in progress. Length, 14.6 miles.

Alameda County, Section B, from Livermore to Hayward (IV—Ala.—5–B): Surveys completed. Plans in progress. Length, 17.7 miles.

Alameda County, Section C, from Hayward to the south boundary of Alameda County (IV—Ala.—5–C): Surveys completed. Length, 17.5 miles.

Contract C_1, from Hayward to Niles: Laid out as State Highway March 25, 1914. Contract (No. 61) awarded April 22, 1914, to Tieslau Brothers. Length, 3.1 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $38,503; per mile, $12,340.

Plans and estimates for remaining portion of Section C are completed.

Alameda County, Section D, from Oakland to Hayward (IV—Ala.—5–D): Laid out as State Highway March 25, 1914. Contract (No. 62) awarded April 22, 1914, to Ransome-Crummey Co. Length, 5.1 miles. Pavement, asphalt on macadam, 24 feet wide. Probable total cost, $56,955; per mile, $11,256.

Santa Clara County, Section A, from the north boundary of Santa Clara County to San Jose (IV—S. Cl.—5–A): Surveys, plans and estimates completed. Length, 7.2 miles.

Santa Clara County, Section B, from San Jose to the south boundary of Santa Clara County (IV—S. Cl.—5–B): Surveys completed. Plans in progress. Length, 14.48 miles.

Santa Cruz County, Section A, from the north boundary of Santa Cruz County to the city of Santa Cruz. (IV—S.Cr.—5–A): Survey complete. Length, 16.0 miles.

Contract A_1, from the north boundary of Santa Cruz County to Glenwood: Laid out as State Highway Jan. 21, 1914. Contract (No. 49) awarded Feb. 26, 1914, to Martin S. Foss and John A. Marshall. Length, 5.7 miles. Road is to be graded 18 feet wide. Probable total cost, $62,366; per mile, $10,910. Amount of contract completed May 16, 1914, 10 per cent.

Contract A_2, from Glenwood to Santa Cruz: Plans and estimates completed. Length, 10.3 miles. Bids will be received July 6 for grading.

ROUTE 6. ACROSS YOLO BY-PASS.

Yolo County, Section A, from 2 miles west of Davis to Southern Pacific bridge 81A (III—Yolo—6–A): Surveys completed. Plans in progress. Length, 7.5 miles.

Yolo County, Section B, from Southern Pacific bridge 81A to West Sacramento levee (III—Yolo—6–B): Laid out as State Highway April 22, 1914. Bids received June 8, 1914; award pending. Length, 3.1 miles. The road is wooden trestle for about .4 mile, and reinforced concrete trestle with draw span for about 2.7 miles.

Yolo County, Section C, from West Sacramento levee to the Sacramento River (III—Yolo—6–C): Surveys completed. Plans in progress. Length, 3.9 miles.

ROUTE 7. THROUGH THE WESTERN SACRAMENTO VALLEY.

Solano County, Section A, from Benicia to a point 2½ miles south of Cordelia (III—Sol.—7–A): Laid out as State Highway March 25, 1914. Contract (No. 79) awarded June 10, 1914, to Commary-Peterson Co., Inc. Length, 9.1 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $103,770; per mile, $11,466.

Solano County, Section B, from a point 2½ miles south of Cordelia to Fairfield (III—Sol.—7–B): Survey completed. Plans in progress. Length, 9.6 miles.

Solano County, Section C, from Fairfield to Vacaville (III—Sol.—7–C): Laid out as State Highway May 27, 1914. Contract (No. 74) awarded June 10, 1914, to Commary-Peterson Co., Inc. Length, 8.8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $90,350; per mile, $10,265.

Solano County, Section D, from Vacaville to a point three fourths of a mile northeast of Batavia (III—Sol.—7–D): Surveys completed. Plans in progress. Length, 8.2 miles.

Solano County, Section E, from a point three fourths of a mile northeast of Batavia to the north boundary of Solano County (III—Sol.—7–E): Surveys completed. Length, 8.4 miles.

Yolo County, Section A, from the south boundary of Yolo County to Woodland (III—Yolo—7–A): Plans and estimates completed. Length, 11.7 miles. Bids will be received July 6 for construction of Portland cement concrete.

Yolo County, Section B, from Woodland to Bretona (III—Yolo—7–B): Surveys completed. Plans in progress. Length, 11.0 miles.

Yolo County, Section C, from Bretona to the north boundary of Yolo County (III—Yolo—7–C): Surveys completed. Plans in progress. Length, 11.0 miles.

Colusa County, Section A, from the south boundary of Colusa County to Berlin (III—Col.—7–A): Laid out as State Highway May 27, 1914. Bids received May 25, 1914; award pending. Length, 10.82 miles.

Colusa County, Section B, from Berlin to Colusa Junction (III—Col.—7–B): Surveys completed. Plans in progress. Length, 12.7 miles.

Colusa County, Section C, from Colusa Junction to the north boundary of Colusa County (III—Col.—7–C): Surveys completed. Plans in progress. Length, 10.7 miles.

Glenn County, Section A, from the south boundary of Glenn County to Willows (III—Gle.—7–A): Surveys completed. Plans in progress. Length, 8.6 miles.

Glenn County, Section B, from Willows to Grapit (III—Gle.—7–B): Surveys completed. Plans in progress. Length, 10.0 miles.

Glenn County, Section C, from Grapit to the north boundary line of Glenn County (III—Gle.—7–C): Laid out as State Highway April 22, 1914. Contract (No. 77) awarded June 10, 1914, to P. H. Hoare. Length, 6.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $60,550; per mile, $8,725.

Tehama County, Section A, from the south boundary of Tehama County to a point west of Tehama Junction (II—Teh.—7–A): Surveys completed. Length, 15.29 miles.

Contract A_1, from the south boundary to Corning: Laid out as State Highway April 22, 1914. Contract (No. 76) awarded June 10, 1914, to Jacinto, Burns & Da Roza. Length, 8.8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $83,460; per mile, $9,495.

Plans and estimates on the remaining portion of Section A are practically completed.

ROUTE 9. LOS ANGELES AND SAN BERNARDINO COUNTIES.

Los Angeles County, Section A, from San Fernando road to La Canada (VII—L. A.—9–A): Surveys completed. Plans in progress. Length, 13.9 miles.

Los Angeles County, Section B, from La Cañada to Pasadena (VII—L. A.—9–B): Surveys in progress.

San Bernardino County, Section A, from Upland to Citrus Avenue (VII—S. Bd.—9–A): Laid out as State Highway Oct. 29, 1913. Contract (No. 46) awarded Nov. 21, 1913, to Hudson-Johnson Construction Co. Length, 10.4 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $77,268; per mile, $7,462. Amount of contract completed May 16, 1914, 36 per cent.

San Bernardino County, Section B, from Citrus Avenue to Rialto (VII—S. Bd.—9–B): Survey completed. Length, 4.0 miles. See Section C.

San Bernardino County, Section C, from Rialto to San Bernardino (VIII—S. Bd.—9–C): Survey completed. Length, 1.8 miles. Sections B and C laid out as State Highway July 23, 1913. Contract (No. 38) awarded Aug 11, 1913, to C. J. Flower. Length, 5.8 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $45,925; per mile, $7,879. Amount of contract completed May 16, 1914, 82 per cent.

San Bernardino County, Section D, from the San Bernardino-Los Angeles county line to Upland (VII—S. Bd.—9–D): Laid out as State Highway Jan. 21, 1914. Contract (No. 53) awarded Feb. 26, 1914, to Louis Ferrell. Length, 1.7 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $17,375; per mile, $10,305. Amount of contract completed May 16, 1914, 15 per cent.

ROUTE 10. BETWEEN VISALIA AND HANFORD.

Tulare County, Section A, between Visalia and the west boundary of Tulare County (VI—Tul.—10–A): Surveys, plans and estimates completed. Length, 9.22 miles.

Kings County, Section A, between Hanford and the east boundary of Kings County (VI—Kin.—10–A): Surveys, plans and estimates complete. Length 9.28 miles.

ROUTE 11. SACRAMENTO AND EL DORADO COUNTIES.

Sacramento County, Section A, from Folsom to the east boundary of Sacramento County (III—Sac.—11–A): Surveys completed and plans in progress. Length, 6.8 miles.

El Dorado County, Setion A, from the west boundary of El Dorado County to Shingle Springs (III—E. D.—11–A): Surveys completed. Plans in progress. Length, 10.4 miles.

El Dorado County, Section B, from Shingle Springs to El Dorado (III—E. D.—11–B): Laid out as State Highway May 21, 1913. Bids received and rejected June 30, 1913. Now being constructed by the State with day labor (No. D2). Length, 5.3 miles. Pavement, waterbound macadam, 12 feet wide. Probable total cost, $25,608; per mile, $4,859. Amount of section complete May 16, 1914: Grading, 100 per cent; macadam, 50 per cent.

El Dorado County, Section C, from El Dorado to Placerville (III—E. D.—11–C): Laid out as State Highway Jan. 21, 1914. Bids received and rejected March 30, 1914. Now being constructed by the State with day labor (No. D5). Length, 6.6 miles. Pavement, waterbound macadam, 12 feet wide. Probable total cost, $61,219; per mile, $9,318.

ROUTE 12. BETWEEN SAN DIEGO AND EL CENTRO.

San Diego County, Section A, from East San Diego to La Mesa (VII—S. D.—12–A): Laid out as State Highway March 25, 1914. Contract (No. 59) awarded April 22, 1914, to C. L. Hyde Construction Co. Length, 2.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $18,590; per mile, $9,460.

San Diego County, Section B, from La Mesa to El Cajon (VII—S. D.—12–B): Plans and estimates completed. Length, 1.6 miles. Bids will be received July 6 for construction of Portland cement concrete.

San Diego County, Section C, from El Cajon to Alpine (VII—S. D.—12–C): Surveys and plans completed. Length, 14.5 miles.

San Diego County, Section D, from Alpine to Oak Valley road (VII—S. D.—12–D): Surveys completed. Plans in progress. Length, 16.7 miles.

San Diego County, Section E, from Oak Valley road to Glencoe school (VII—S. D.—12–E): Surveys completed. Plans in progress. Length, 6.9 miles.

San Diego County, Section F, from Glencoe school to Tecate Divide (VII—S. D.—12–F): Surveys in progress.

San Diego County, Section G, from Tecate Divide to the east boundary of San Diego County (VII—S. D.—12–G): Surveys ordered.

San Diego County, Section H, from the east city limits of San Diego to the old east city limits of East San Diego (VII—S. D.—12–H): Surveys and plans complete. Length, 3.5 miles.

Imperial County, Section A, from the foot of Myers Canyon to Coyote Wells (VII—Imp.—12–A): Surveys, plans and estimates completed. Length, 6.1 miles.

Imperial County, Section B, from Coyote Wells to Dixieland (VII—Imp.—12–B): Surveys and plans completed. Length, 11.8 miles.

Imperial County, Section C, from Dixieland to El Centro (VII—Imp.—12–C): Surveys and plans completed. Length, 12.3 miles.

Imperial County, Section D, from the west county line of Imperial County to the foot of Myers Canyon (VII—Imp.—12–D): Survey ordered.

ROUTE 13. STANISLAUS AND TUOLUMNE COUNTIES.

Stanislaus County, Section A, from Salida to Oakdale (III—Sta—13–A): Surveys completed. Length, 14.4 miles.

Stanislaus County, Section B, from Oakdale to the northeast boundary of Stanislaus County (III—Sta.—13–B): Surveys completed. Length, 12.9 miles.

Tuolumne County, Section A, from the southwest boundary of Tuolumne County to a point 2 miles north of Keystone (III—Tuo.—13–A): Laid out as State Highway Jan. 21, 1914. Bids received and rejected March 30, 1914. To be constructed by the State with day labor (No. D6). Length, 10.9 miles. Road to be graded 18 feet wide. Probable total cost, $48,700; per mile, $4,490.

Tuolumne County, Section B, from a point 2 miles north of Keystone to Sonora III—Tuo.—13–B): Surveys complete. Plans in progress. Length, 11.3 miles.

ROUTE 14. CONTRA COSTA COUNTY.

Contra Costa County, Section A, from the south boundary of Contra Costa County to Pinole (IV—C. C.—14–A): Surveys completed. Plans in progress. Length, 7.86 miles.

Contra Costa County, Section B, from Pinole to Martinez (IV—C. C.—14–B): Surveys completed. Plans in progress. Length, 12.9 miles.

ROUTE 15. COLUSA TO WILLIAMS.

Colusa County, Section A, from Colusa to Williams (III—Col.—15–A): Surveys completed. Length, 8.5 miles.

ROUTE 16. HOPLAND TO LAKEPORT.

Mendocino County, Section A, from Hopland to the east boundary of Mendocino County (I—Men.—16–A): Reconnaissance made.

Lake County, Section A, from the west boundary of Lake County to Lakeport (I—Lake—16–A): Reconnaissance made.

ROUTE 17. PLACER AND NEVADA COUNTIES.

Placer County, Section A, from Roseville to Penryn (III—Pla.—17–A): Surveys completed. Length, 9.1 miles.

Placer County, Section B, from Penryn to Auburn (III—Pla.—17–B): Surveys completed. Length, 6.5 miles.

On remainder of the route reconnaissance has been made.

ROUTE 18. MERCED AND MARIPOSA COUNTIES.

Merced County: Surveys in progress.

Mariposa County: Surveys in progress.

ROUTE 19. LOS ANGELES TO RIVERSIDE.

Los Angeles County: Built by the county.

San Bernardino County, Section A, from the San Bernardino-Los Angeles county line to Ontario (VII—S. Bd.—19–A): Survey completed. Length, 2.0 miles. See Section B.

San Bernardino County, Section B, from Ontario to the San Bernardino-Riverside county line (VII—S. Bd.—19–B): Survey completed. Length, 4.6 miles. Sections A and B laid out as State Highway June 25, 1913. Contract (No. 37) awarded as a whole July 23, 1913, to Bent & Pennebaker. Length, 6.6 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $52,836; per mile, $7,994. Amount of contract completed May 16, 1914, 100 per cent, but not fully paid.

Riverside County, Section A, from the Riverside-San Bernardino county line to Riverside (VII—Riv.—19–A): Laid out as State Highway Sept. 24, 1913. Contract (No. 43) awarded Oct. 29, 1913, to The M. R. Company, Inc. Length, 10.3 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $59,175; per mile, $6,338. Amount of contract completed May 16, 1914, 43 per cent.

ROUTE 20. REDDING TO WEAVERVILLE.

Shasta County, Section A, from the west boundary of Shasta County to Stella (II—Sha.—20–A): Surveys in progress. Length, 13.0 miles.

Shasta County, Section B, from Stella to Redding (II—Sha—20–B): Surveys in progress. Length, 10.9 miles.

Trinity County, Section A, from Weaverville to the Trinity River (II—Tri.—20–A): Surveys in progress. Length, 13.0 miles.

Trinity County, Section B, from the Trinity River to the east boundary of Trinity County (II—Tri.—20–B): Survey ordered. Length 11.0 miles.

ROUTE 21. OROVILLE TO RICHVALE.

Butte County, Section A, from Richvale to Oroville (III—But.—21–A): Survey ordered.

Notice to Contractors

Sealed proposals will be received at the office of the California Highway Commission, 515 Forum Building, Sacramento, Cal., until the times hereinafter noted, at which times they will be publicly opened and read, for construction in accordance with the specifications therefor, to which special reference is made, portions of State Highway as follows:

(Until 11 o'clock A. M., July 6th, 1914.)

Tehama County from the South Boundary to Los Molinos (II—Teh—3-A), about 10.6 miles in length, to be built of Portland cement concrete.

Yolo County from the Southerly Boundary to Woodland (III—Yol—7-A), about 11.7 miles in length, to be built of Portland cement concrete.

Santa Cruz County from Glenwood to Santa Cruz (IV—S. Cr—5-A), about 10.3 miles in length, to be graded.

Santa Barbara County from Orcutt to Santa Maria (V—S. B.—2-A), about 6.5 miles in length, to be built of Portland cement concrete with asphaltic wearing surface.

San Benito County from San Juan Bautista to the Northerly Boundary (V—S. Bt—2-A), about 4.0 miles in length, to be built of Portland cement concrete.

(Until 2 o'clock P. M., July 6th, 1914.)

Shasta County from Bayha to the Sacramento River (II—Sha—3-B & C), about 16.2 miles in length, to be graded.

San Luis Obispo County from Arroyo Grande to San Luis Obispo (V S.L.O—2-E), about 13.4 miles in length, to be built of Portland cement concrete.

Kern County from Grape Vine Creek to Sections 5 & 6, T. 32 S., R. 28 E. M. D. B. & M.(VI—Ker.—4-B), about 17.3 miles in length, to be built of Portland cement concrete.

Ventura County from Newbury Park to Springville (VII—Ven—2-B), about 11.1 miles in length, to be built of Portland cement concrete.

San Diego County from La Mesa to El Cajon (VII—S.D—12-B), about 1.6 miles in length, to be built of Portland cement concrete.

Plans may be seen, and forms of proposal, bonds, contract, and specifications may be obtained, at the said office, and they may be seen at the offices of the Division Engineers of the divisions in which the work is situated. The Division Engineers' offices are located at Willits, Dunsmuir, Sacramento, San Francisco, San Luis Obispo, Fresno, and Los Angeles.

No bid will be received unless it is made on a blank form furnished by the Commission. The special attention of prospective bidders is called to the "Notice to Contractors" annexed to the blank form of proposal, for full directions as to bidding, quantities of work to be done, etc.

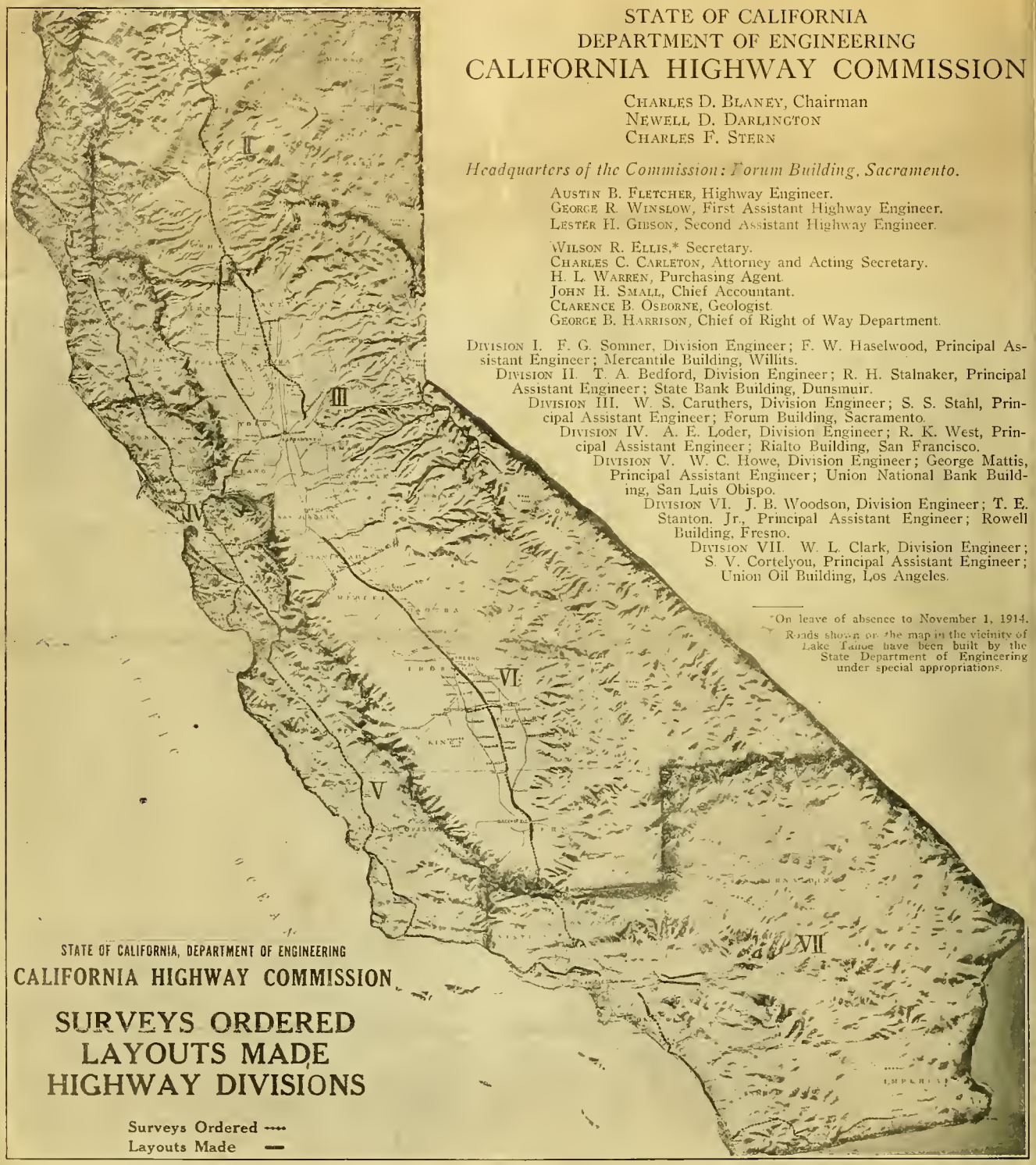
The Department of Engineering reserves the right to reject any or all bids or to accept the bid deemed for the best interests of the State.

CHARLES D. BLANEY,
NEWELL D. DARLINGTON,
CHARLES F. STERN,
California Highway Commission.

Dated June 9, 1914.

AUSTIN B. FLETCHER, Highway Engineer.
CHARLES C. CARLETON, Acting Secretary.

"The four most important requirements for a concrete base are: A firm, compact subgrade, true to line and grade; a concrete of a proper consistency; a uniformly finished surface true to line and grade; and the finished concrete constantly and faithfully guarded during the curing period."—*L. H. Gibson, Second Assistant Highway Engineer, California Highway Commission.*



STATE OF CALIFORNIA
DEPARTMENT OF ENGINEERING

CALIFORNIA HIGHWAY COMMISSION

CHARLES D. BLANEY, Chairman
NEWELL D. DARLINGTON
CHARLES F. STERN

Headquarters of the Commission: Forum Building, Sacramento.

AUSTIN B. FLETCHER, Highway Engineer.
GEORGE R. WINSLOW, First Assistant Highway Engineer.
LESTER H. GIBSON, Second Assistant Highway Engineer.

WILSON R. ELLIS,* Secretary.
CHARLES C. CARLETON, Attorney and Acting Secretary.
H. L. WARREN, Purchasing Agent.
JOHN H. SMALL, Chief Accountant.
CLARENCE B. OSBORNE, Geologist.
GEORGE B. HARRISON, Chief of Right of Way Department.

DIVISION I. F. G. Sonner, Division Engineer; F. W. Haselwood, Principal Assistant Engineer; Mercantile Building, Willits.

DIVISION II. T. A. Bedford, Division Engineer; R. H. Stalnaker, Principal Assistant Engineer; State Bank Building, Dunsmuir.

DIVISION III. W. S. Caruthers, Division Engineer; S. S. Stahl, Principal Assistant Engineer; Forum Building, Sacramento.

DIVISION IV. A. E. Loder, Division Engineer; R. K. West, Principal Assistant Engineer; Rialto Building, San Francisco.

DIVISION V. W. C. Howe, Division Engineer; George Mattis, Principal Assistant Engineer; Union National Bank Building, San Luis Obispo.

DIVISION VI. J. B. Woodson, Division Engineer; T. E. Stanton, Jr., Principal Assistant Engineer; Rowell Building, Fresno.

DIVISION VII. W. L. Clark, Division Engineer; S. V. Cortelyou, Principal Assistant Engineer; Union Oil Building, Los Angeles.

*On leave of absence to November 1, 1914.

Roads shown on the map in the vicinity of Lake Tahoe have been built by the State Department of Engineering under special appropriations.

Types of Highway Construction

"The Commission has invariably attempted to design the state highways to suit the requirements of topography and traffic and accordingly there are six different types of road construction in the work as planned. The list of road surfaces, some of which are available for use in California and some which are not, is a very long one. Each has its earnest advocates and the persons and corporations which control patents or who manufacture the materials used are extraordinarily active in presenting their particular types. That any one type of road surface will suit all conditions is absurd. There is no 'most satisfactory' road surface which will answer all the factors of finance, topography, climate and traffic. The question of finance alone has barred out from general use some of the high cost pavements which have been advocated for the California state highways."—*A. B. Fletcher, Highway Engineer, California Highway Commission.*

CALIFORNIA HIGHWAY BULLETIN

PUBLISHED BY THE CALIFORNIA HIGHWAY COMMISSION

DEPARTMENT OF ENGINEERING, STATE OF CALIFORNIA

VOLUME III | JANUARY 1, 1915 | NUMBER 1

ON THE COAST ROUTE OF CALIFORNIA STATE HIGHWAY

CALIFORNIA STATE PRINTING OFFICE, SACRAMENTO

California Highway Bulletin

CALIFORNIA HIGHWAY COMMISSION
FORUM BUILDING, SACRAMENTO

CHARLES D. BLANEY, Chairman; N. D. DARLINGTON, C. F. STERN, Members. A. B. FLETCHER, Highway Engineer. W. R. ELLIS, Secretary. C. C. CARLETON, Attorney.

JANUARY 1, 1915

Published by the California Highway Commission for free distribution
GEORGE B. HARRISON, Editor, 541 Rialto Building, San Francisco

State Highway Progress

In this number of the Highway Bulletin a summary is presented of the status of work on the State Highway. The Highway Bulletin, in fact, is designed to offer a public report of progress in the construction provided in the State Highways Act.

When permanent highway building is under consideration it must be remembered that new and more exacting traffic requirements are to be met, that the roads must represent a service not dreamed of even ten years ago, and that safety and permanence, the two great considerations, call for more preliminary care than appears to the traveler on the finished highway. Some consideration also may be given to the backward financial conditions which have not made disposal of low-rate bonds an easy matter, even for the State of California.

Queries come constantly to the California Highway Commission and its representatives regarding the character or amount of work on the State Highway, and it is intended to present a full answer to these in this number of the Highway Bulletin. If additional information is desired it will be furnished gladly upon application to the Commission.

Temporary Roads

One of the problems in highway construction is to find an acceptable method to take care of the traffic while the highway improvement is under way. Parallel roads, available by short detours, are found infrequently, and ordinarily some sort of a temporary road must be provided. This provision is not always difficult in the summer, but when the rains come the difficulty increases many fold. Construction must proceed at as rapid a rate as possible, while travel must be impeded to the smallest feasible extent; the old road and its bridges must be torn up and rebuilt, and yet it is not expedient to spend much money on the by-road for use less than a year.

In some cases, as in the so-called "Tejon route," the State Highway cuts through directly and does not interfere with the old traveled route. On other mountain roads the old road and the new conflict at points where it is difficult or perhaps impossible to provide any other, and a detour over an entirely different road is unavoidable. In the Great Valley and on other level sections the question of by-passes is more easily settled.

At best, however, the temporary road is far from satisfactory, and causes the traveler inconvenience. Against its roughness and added mileage should be placed the fact that the inconvenience of a few months is in order to give for all time in future a model road which will save in comfort and expense on a single trip more than enough to offset the disadvantages. Although the temporary road may not show it to the casual observation of the traveler special efforts are made by the supervisors and the Highway Commission to provide as good a road as possible without going to an extravagant outlay. As construction progresses signs designating the "best temporary route" are placed at turns, and caution notices are provided in accordance with road conditions. The automobile organizations render valuable assistance in this regard by route directions and in sign placing. The signing problem is a difficult one, for directions apparently clear to one person may be misunderstood by another, and frequently the driver with a "speed bug" pays no attention at all until an accident occurs.

Travelers through the state over routes where much construction is under way may save time and some trouble by securing information as to route conditions from one of the automobile associations, whose officers are always ready to answer inquiries, or at any of the offices of the California Highway Commission, a list of which is given elsewhere in this number of the Highway Bulletin. The automobile clubs publish weekly bulletins giving definite information as to road conditions on the principal routes. A little forethought in making inquiries may save the motorist mileage.

During 1915 it will be the policy of the California Highway Commission to make special efforts in cooperation with county supervisors to maintain all temporary routes, especially between San Francisco and Los Angeles and San Diego wherever needed, in better-than-ordinary condition to meet the unusually large traffic of the exposition year. Where the grading must be left for the settling rains of one or two winters before placing the pavement, as will be the case on both the valley and coast routes between San Francisco and Los Angeles, the temporary surfacing will be firm and safe, and the traveler will have all the advantages of easy grades and safe curves. The roads between the two expositions, if not entirely paved, will be open and safe and greatly improved over the roads of 1913.

Mountain Roadways

Perhaps in no part of the work of the California Highway Commission is the advantage of modern road making better shown than in the construction of the mountain sections of the State Highway. The old roads, in most cases, were outgrowths of trails, and grades in excess of twenty per cent were not uncommon, while sharp curves and narrow widths demonstrated that they were made before automobiles came on the market. Of late years many county authorities have made commendable progress in the mountain counties, but the expense of building a modern mountain road is greater than any county is justified in expending locally and is properly a state charge. This is particularly true in the mountains, for the development accruing from the best types of highways almost always extends from one county to another or is of special benefit to through traffic.

The state can, and should, construct a better type of road than a county can build—and this is in no way a disparagement of the work of county supervisors, who are inevitably called upon to expend more money than they have available. Their work is to meet local needs, while the state should undertake construction with an eye toward facilitating through traffic as well as local travel. Consequently the California Highway Commission has planned mountain roads, as the State Highways Act directs, on the "most direct and practical" routes for the through travel, while at the same time connecting the county seats with the remainder of the state. On the trunk lines of the State Highway the maximum grade will be 6 per cent, a trotting grade for a team with light rig, except for a comparatively few short pitches of 6½ or 7 per cent. The trunk routes will be paved in the mountains, and will be so safeguarded that the most timid drivers may enjoy mountain touring. On the laterals, where the traffic is much lighter, the expense of a 7 per cent maximum or of paving is not justified.

In addition to their appeal to the tourist or intending settler—which alone will bring millions of dollars into California—the mountain roads of the State Highway will bring into closer touch with the cities and seaports a number of sections now almost isolated geographically. In Modoc, Lassen, Plumas and Sierra counties, for example, California has a veritable empire needing only good roads to attract attention to its possibilities. Counties even nearer to the capital, like Nevada, Placer and Calaveras, will rank with the richest horticultural counties in the state when supplied with adequate communications to tidewater. With good roads Mono and Inyo counties will appeal annually to thousands of tourists. All the mountainous counties of the state, whether well known or seldom visited, will offer attractions in scenery, in ranching or stock raising and in fishing or hunting heretofore little appreciated for lack of good roads.

In its studies of possible routes for the main trunk roads of the State Highway the Commissioners and the Highway Engineer traveled by automobile 6,800 miles, and in studying the mountain lateral problems during the past summer they went over an additional 2,100 miles, making practically 9,000 miles traversed in order to work out the preliminaries for the construction of the 3,000 miles of road comprehended in the State Highway system.

The value of an "engineered road" is shown in the State Highway connection between Southern California and the San Joaquin Valley, on which, in addition to provision of a maximum grade of 6 per cent and the avoidance of sandy stretches, sharp curves and other "bad going," actually effects a saving of forty-five miles over the shortest old route.

Thousands of persons interested in road improvement will visit California in 1915, and there are few phases of highway building which will not be available for inspection in the State Highway system.

PROTECTING THE PUBLIC

Safeguards Provided to Meet Financial and Moral Responsibilities in Connection with State Highway Contracts

By Charles F. Stern,
Member California Highway Commission.

In its financial relations with its contractors, the Highway Commission differs but little from any large employer of labor under the contract system. The credit and financial responsibility of the state are just as separate from the credit and financial responsibility of the contractor as in any private or corporate contract. Yet, there is a certain moral responsibility involved; to an extent, the reputation and the credit of the state are placed in the hands of the contractor to whom a contract for a section of State Highway is let. To this moral responsibility the Highway Commission is keenly alive. No one wants the State Highway to contain an ounce of material or an hour of labor for which the seller has not been paid. This applies both to the contractor and to those who furnish him with supplies, material or labor.

The contractor is presumed to know his business. The contract which he takes is on his own bid, at his own price, and on specifications which definitely define every element that enters into the work. Notwithstanding this, the Commission takes extraordinary pains to aid the contractor in the successful completion of his work, precautions that are not taken to protect a contractor or the public in either private or corporate construction.

The materials for the work—rock, sand, cement, etc.,—are furnished by the state. This saves the contractor a considerable investment and incidentally places the work within reach of the resources of a large number of contractors. The Commission pays for its work in a way most unusual. "Progress estimates," or estimates of the work done, are made every thirty days, and in places where it is necessary, oftener, and the money due for such work is promptly paid. This materially lessens the contractor's investment in labor and supplies, and correspondingly eases the burden of the work. The state places at the disposal of the contractor the highest type of engineering advice and assistance.

On the part of those who supply the contractor with hay or grain, groceries, powder, or labor, or any other commodity, the matter is more complicated. There is no question but that a contractor on the State Highway finds it much easier to get credit locally than he would were he working for a railroad, for example. "It is State Highway work, the state is good for it," seems to be the general impression.

Now, as a matter of fact, the creditor of a Highway contractor has no recourse to the state other than the ordinary legal procedure which would obtain in any private or corporate work. Even labor itself is not a preferred creditor under the law. For sentimental reasons, too, the local dealer is proud to furnish supplies for the Highway work—proud to have a hand in this great constructive enterprise.

The Highway Commission goes to extreme lengths in its effort to protect these claims. Two bonds are required of the contractor who enters upon a Highway contract for the full amount of his bid. Before a contract is let, a searching examination is made into the reputation, ability, and financial responsibility of the contractor. The Highway Commission does not propose to have its work in the hands of any contractor whose record and resources are not sufficient to warrant the presumption that he can carry out his contract with satisfaction to the state and to the public. As the work progresses, 15 per cent is deducted from each progress estimate, constituting a "retention fund," which is not released until the job has finally been completed and accepted by the state. This is to protect any claims that may arise against the contractor.

These precautions in themselves would seem sufficient, but the Highway Commission goes yet further. Article XI of the contract entered into between the state and the contractor reads as follows:

> "Said contractor further agrees that he will pay all bills for labor, material and supplies contracted for by him on account of the work herein contemplated, when same become due and payable, and that he will furnish to the California Highway Commission on the fifteenth of each month, a sworn statement of all unpaid indebtedness contracted for on account of the work herein contemplated, together with the dates of such bills and the names and addresses of such creditors.
>
> The Department of Engineering, through the California Highway Commission, at its option and at any time by written notice to the Contractor, upon the failure of Contractor to furnish such statement, or upon proof that the contracted indebtedness is not being met when due, may declare this contract terminated, and may itself proceed to complete the work herein specified, or engage any other person or persons to do the same.

Motor Car Clearance on Minimum Improved Width of State Highway

Moreover, said State of California, by and through the Department of Engineering or other appropriate state officer or officers, may at its option and at any time retain out of any amounts due said Contractor sums sufficient to cover any such unpaid claims, provided that sworn statements of said claims shall have been filed in the office of the Department of Engineering or in the office of any other state officer or officers; and, furthermore, said State of California, by and through the Department of Engineering or other appropriate state officer or officers, may at its option and at any time pay any such unpaid claims out of the amounts so retained. The Department of Engineering may also, with the written consent of the Contractor, use any moneys in the possession of the State of California belonging to the said Contractor for the purpose of paying for both labor and materials for the work.

In the event that the party of the first part declares this contract terminated, as provided by this article or by Article VII herein, the Department of Engineering, through the California Highway Commission, reserves the further right to take possession of and use any materials or equipment of any nature whatsoever belonging to or used by said Contractor on the work herein contemplated, the Department of Engineering assuming responsibility for the final relinquishment of such equipment at the conclusion of the work or sooner at its option, in as good condition as when it was taken over by said department, reasonable wear and tear excepted; and the Department of Engineering, through the California Highway Commission, agrees to pay for the use of said equipment or material a reasonable compensation, to be mutually agreeable to the Commission and the Contractor, or, in the event of their failure to reach such agreement, then such compensation as may be determined upon by the Advisory Board of the Department of Engineering of California."

The intent and significance of this article are too plain to require elucidation. By virtue of this provision the Commission keeps definite tab on the financial obligations of the contractor, with the intent that when it becomes apparent that the contractor is becoming involved, that the state shall intervene to protect the creditors of the contractor before their claims aggregate an amount in excess of the retention fund. This provision will prevent a recurrence of former failures on the part of contractors wherein claims for labor, material, and supplies were unpaid for many months, awaiting the tardy action of the bonding company, and were then subject to compromise.

It is inevitable that from time to time contractors will fail. This is the hazard of all business. The Highway Commission surrounds its relations with its contractors and their bondsmen with such conditions as to protect to the fullest extent the creditors of the contractor. And in the event of the failure of the contractor, every effort is made to see that claims for labor, material and supplies are liquidated promptly and in full from the retention fund if it be large enough; if not, then by the prompt action of the creditors' bondsmen. The Highway Commission does not look with favor upon any bonding security which can not be depended upon for prompt cooperation and definite action to this end.

In recent instances wherein contractors have failed, their contracts have been immediately transferred to other parties nominated either by the state or the bondsmen, and all claims have been settled in full with a celerity impossible under any less drastic or far seeing arrangement.

The interest and support of the people at large in the highway work is a matter of pride and is to be encouraged to the utmost. The moral responsibility of the state must be, and will be, fully shouldered, regardless of the legal nonresponsibility behind which a private or corporate enterprise is willing to hide.

From time to time a contractor falls by the wayside. The percentage on this work is small—a half dozen in one hundred seven jobs handled. When this happens, every resource of the state is brought to bear to protect the innocent creditor. But the man who sells his labor or the dealer who sells supplies must bear in mind that his business is done with the contractor and not with the state; that the interests of the state, representing the whole people, must be protected as well as the interests of the small proportion who chance to be creditors; that the law itself knows no favorites. Indiscriminate credit exacts its own penalties, here or elsewhere.

Studying Mountain Laterals

In advance of the preparation of plans for State Highway construction the Highway Commissioners and the Highway Engineer made a series of studies of the main lines prescribed in the State Highways Act, traveling six thousand eight hundred miles by automobile between Siskiyou and Del Norte counties on the north and San Diego County on the south. These studies were only on probable routes for the principal lines through the great valley and along the coast, comprehending what are sometimes referred to as the "trunk roads" of the State Highway system.

As each county was visited an approximation was made of the probable total mileage of State Highway in the county and information was secured from supervisors, county surveyors and others interested, which served as the basis, in conjunction with additional data collected at the office in Sacramento, for a rough apportionment, county by county, of the $18,000,000 provided for State Highway construction. From this skeleton plan was worked out the working scheme for building the State Highway. The visits to the various counties, which were made while awaiting the first sales of bonds, also proved valuable to the Commissioners in giving them first-hand information about the country through which the State Highway must be built.

Similar studies of the lateral lines which will be built to connect the county seats not on the principal routes were undertaken by the Commissioners during the past summer. These lines may be considered the second great phase of the State Highway work, the building of the system through the valleys and along the coast being the first. Since the latter was well under way this year the Commissioners took up the former, initiating that work by a series of personal studies similar to those made on the main lines in 1911. In August and September they traveled more than two thousand miles in Placer, Nevada, Sierra, Plumas, Lassen, Modoc, Shasta, Tehama, Butte, Yuba, Amador, Alpine, Calaveras, Tuolumne, Mariposa, Madera, Mono, Inyo and Kern counties to obtain an idea of the best method for tying those counties to the main lines.

Starting from Sacramento, the possible routes between the Sacramento Valley main route and Auburn were traversed and routes to connect Nevada City via Grass Valley with the main route by three suggested laterals—the direct route to Auburn, the Colfax route and the Smartsville old toll road to Marysville—were traveled in considering the Nevada County tie-up. The possibility of a "Y" for Nevada City and Downieville with the two roads coming together in Brown's Valley and connecting at Marysville was considered, as well as a more southerly connection for Downieville. The Commissioners went from Downieville to Quincy and traveled over the various routes suggested for the Plumas County tie-up. They next visited Susanville and Alturas and traveled over connections for Modoc and Lassen counties by way of Redding and Red Bluff. On the return, the tie-up for Oroville was studied. A trip was next made to Markleeville in Alpine County to consider the probable tie-up for that county seat.

As soon as business matters in the headquarters office at Sacramento were disposed of, the Commissioners continued their studies of lateral routes by traveling from Sacramento to Jackson and over the routes to and from San Joaquin Valley points and the mountain county seats, Jackson, San Andreas, Sonora and Mariposa. The probable connection for Mono and Inyo counties was then studied, the Commissioners going from Sonora over the Sonora Pass to Bridgeport and then traveling along the route through Mono Lake, Bishop, Big Pine, Independence, Lone Pine and Mojave. On the way an inspection was made of the Tioga Pass route at the Mono Lake end.

At the meeting on September 22, the following instruction was voted by the Highway Commission:

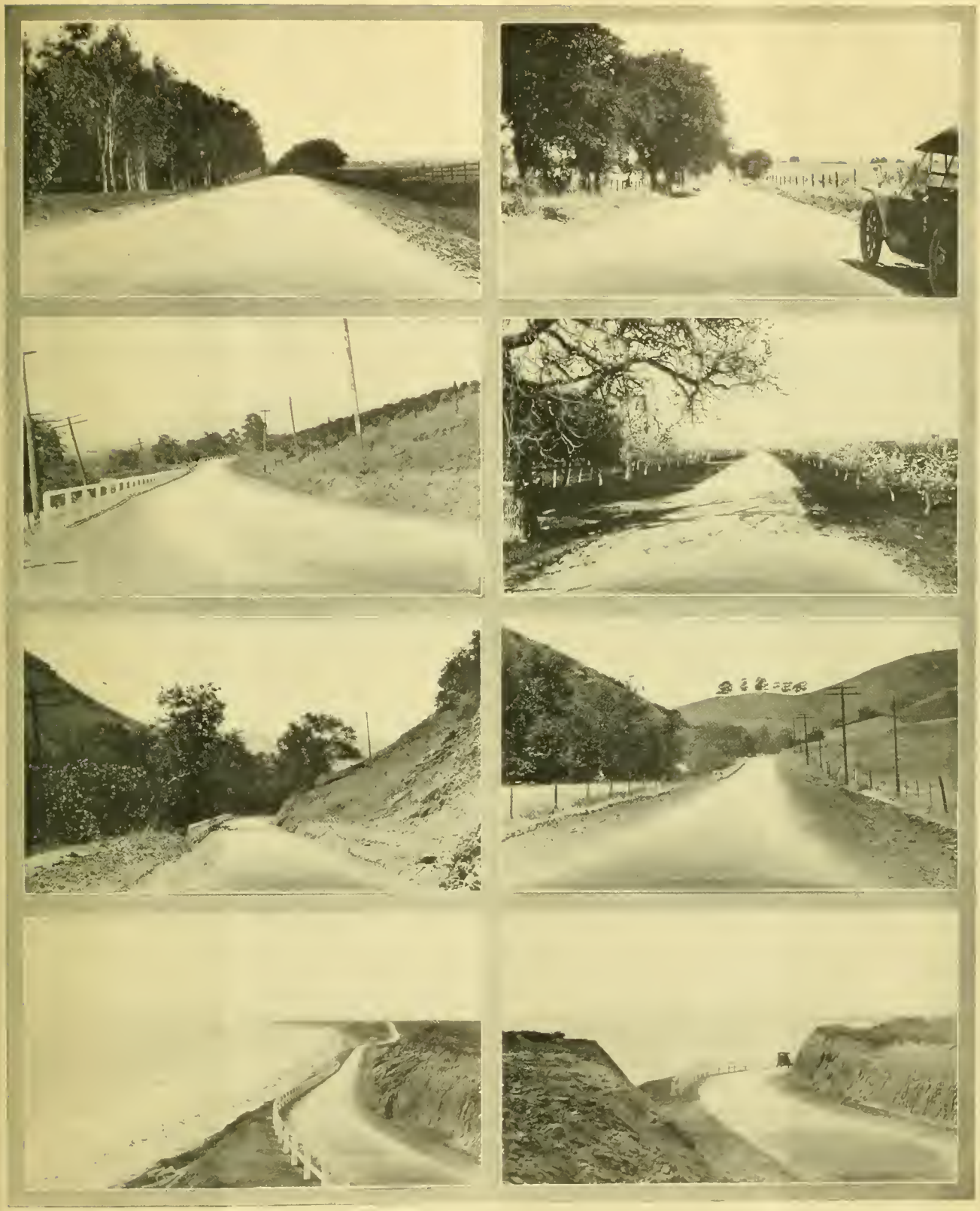
"*Voted*, That the Highway Engineer be and he is hereby instructed to cause to be made through the several Division Engineers and their assistants such reconnaissances and studies of the lateral state highways connecting the county seats with the trunk lines as may be necessary in anticipation of the construction surveys."

Such reconnaissances were made or are being prosecuted as fast as the regular work of the Division Engineer will permit. They have been carried out for Inyo and Mono counties and in Mariposa, Tuolumne, Placer, Nevada, Sierra and Butte counties, and preliminary work has also been done in Amador and Calaveras counties.

Cautionary Signs

(See illustration on page 15.)

A serious problem connected with Highway construction is the handling of traffic when it is found necessary to close the old road during construction. In a well settled community there are usually sufficient roads to provide detours of comparatively short length, but in many sections, and particularly in the mountains, temporary roads must be furnished while the concrete is being laid and cured. Efforts are made by signs and lanterns to direct the traffic as fully as possible to avoid unnecessary travel while the road may be closed. In addition to cautionary signs at the end of the work, "Best Temporary Route" signs are placed along the temporary roads. These are frequently torn down, however, by school children and others who do not realize their value to the traveler, and it is not always possible to maintain an ideal system of signs on temporary roads.



Completed Roads on California State Highway

THE LATERAL ROAD PROBLEM

Secondary Demand of Highways Act is for Connecting County Seats Not Directly on Principal Routes

The primary demand of the California Highway Act is for trunk line construction; for two roughly parallel lines, one through the coast counties and the other through the great interior valleys, the Sacramento and the San Joaquin, "serving county seats and connecting centers of population by the most direct and practical routes." In the skeleton system of highways outlined by the act, these constitute the backbone.

The secondary demand of the act is for lateral road construction; to connect with the highway those county seats which are not directly served by either trunk line.

The trunk lines will constitute the great arteries of road traffic into which will flow the local traffic of every section, as well as the through traffic of the entire Pacific coast. The lateral roads, by location and purpose, are feeders only for the trunk lines. In importance, use, and logical sequence they constitute the subordinate part of the highway scheme.

California Meeting Oregon: Commissioners and Officials of Two States and Counties at the Boundary Line.

In 1911, when the California Highway Commission was considering probable routes for the main roads of the State Highway, a visit was made to Siskiyou County where officials of that county accompanied the Highway Commissioners to the California-Oregon boundary line and there conferred with representatives of Jackson County, Oregon, regarding the interstate highway connection. As a result, the Oregon road will come over the Siskiyou Mountains with a maximum grade of six per cent, joining the California State Highway at the point shown in the illustration.

A glance at the highway map will show that the coast trunk line serves all of the county seats of the coast counties, practically speaking; that the trunk line through the valleys serves all of the county seats of the valley counties, practically speaking. The problem of lateral roads is a problem by itself, in a location by itself. It is the problem of tying the eastern tier of counties, the mountain counties, to the valley trunk line. It consists almost entirely of mountain roads through sections largely undeveloped and sparsely settled, and connecting centers of population—county seats—of no great numerical importance. These facts find their logical expression in the attitude of the Highway Commission toward the mountain laterals; as to time of construction, and character of construction.

More highway was built this year in California than was ever attempted in a single year in any other state. And yet, the roads can not all be built in a season—the money is not available, contractors are not available, right of way questions take time; and there is a limit to the capacity of any organization, however efficient, beyond which speed is obtained only at the cost of efficiency and economy.

Therefore, trunk lines first.

We are now ready to take up the lateral roads as a comprehensive, distinct road problem. The Highway Commission and its engineers in charge in each division have finished two thousand miles, traveling by automobile, through these mountain counties, studying their location, needs and desires at first hand. These county seats, for the most part, lie to the east of the Sierras. Their connecting roads to the valley cross elevations of from 4,500 to 7,500 feet, and are snow blocked for months on end. The problem is to build laterals to these points which will utilize the lowest passes through the mountains and be useable through the winter months. Following the inspection by the Commission, the engineering force will study every detail of this problem, examine every possible or suggested route, in order that the needs, the wishes, and the rights of these communities under the law may be met. That actual work upon the mountain laterals has not been begun does not indicate that the mountain counties have been forgotten, or will be neglected. The spring of 1915 will see this portion of the highway scheme under active headway.

The relation of the lateral to the trunk line expresses itself also in character of construction. The standards of trunk line construction have been set high—no grade in excess of seven per cent, no curves with shorter radii than fifty feet, a twenty-one-foot roadbed, and with ideal alignment, etc. The type of construction has been fixed—the concrete base, permanent type. The lateral roads, however, warrant a much more flexible policy. Some of them, as the Oroville lateral and the Hanford-Visalia lateral, will carry sufficient traffic to warrant trunk line type of construction. On the purely mountain laterals such construction would be folly. No one wants, expects, or needs city streets through the Sierras. An accurate study, therefore, of this problem, will demonstrate the necessity of varying types of construction to meet varying situations. Grades steeper than on the main routes, narrower roadbeds, surfacing of native materials, and similar reasonable economies will be necessary in handling this lateral problem without a prohibitive cost; and at the same time the resulting roads will be godsends to communities where twenty-five per cent grades and narrow, dangerous roads without benefit of sound engineering are to-day the rule.

It will be the policy of the Commission to apply sound engineering to this problem first, that these laterals may be permanently placed where they belong; to expend the apportionment for these roads where it should be spent, eliminating excessive grades, dangerous curves, etc.; to take under maintenance the entire mileage and, where the cost of a perfect road can not be met with the available funds, to lay the foundation for a perfect road and out of our maintenance fund gradually perfect such roads by the addition of guard rails, culverts, retaining walls, surfacing, etc. By such a system the mountain counties will be opened up by roads that lend themselves to safe and economical traffic, and the mountain counties will become a part of California practically the whole year round.

It is a unique compliment to these counties that the Commission has been forced to ask them not to purchase highway bonds until the money can be used. They needed no urging to buy, they were ready and anxious.

And in the meantime, the lateral road problem is being whipped into shape for definite activity next season.

State Highway Materials

At this period of the construction of the California Highway system, it is of considerable interest to note the quantities of material being delivered to the contractors engaged in State Highway construction. During September, 50,700 barrels of cement were delivered on the work from the various cement mills throughout the state, and 63,200 tons of sand and gravel were delivered by rail during the same period. The transportation of this material required over sixteen hundred cars. In addition to these shipments, approximately one hundred cars were used for the delivery of road oil, reinforcing steel, lumber, contractors' equipment and machinery of all kinds; and, during this time, not an instance of serious delay to the work occurred, notwithstanding the fact that there was a noticeable car shortage throughout the entire month, due principally, no doubt, to the heavy movements of grain, fruit and other farm products. This means that an average of sixty-eight cars of material were daily purchased and moved—and moved during a period of car shortage—without an instance of delay to the work.

Rights of Way*

By Austin B. Fletcher
State Highway Engineer of California

Adequate "rights of way" or "locations" are of prime importance in any highway system and too little attention has been given to this feature of highway work hitherto.

In the mad haste to get the roads built so that the automobile enthusiasts may use them "while they are yet alive," we are prone to forget that the highway location is the one really permanent feature of the road work.

The time to secure proper locations for the roads, and widths sufficient to serve all purposes for long years to come, is *now*. If we wait until some future day to correct improper locations, and to secure suitable widths of rights of way when we have more leisure, we will have wasted much money in pavements constructed and the land needed will cost much more and will be more difficult to acquire.

It goes without saying that all land owners are more complacent in giving up portions of their property to the public before the improvements are begun than at any time afterward.

In some of the older states the people came long before "sectionalization" by the government was thought of but in the middle west and on the Pacific coast, most of the land was divided years ago "checkerboard" fashion by the government surveyors.

The highways in the older states were laid out, or in most cases, simply grew where the travel wanted to go, but in the flat prairie land of the west, and even in the Pacific coast valleys, the roads were often, if not generally, laid out straddling the section lines, the center of the right of way being usually coincident with the section line. This plan had the merit of lessening the area of land deducted for road purposes from the holding of an owner by making his adjoining neighbor provide one half of the land required for the roadway.

This method of road location often proves to be an embarrassment to the present-day road builder since this time-honored rectilinear scheme does not fit the present needs. Centers of population often times have not occurred in conformity to such a plan; often the railroads have determined the location of the towns. In such cases it is desirable, considering the volume of "through travel" in motor cars and trucks, to construct the roads in the most direct lines possible. This often entails rights of way running diagonally across the sections, "cuts up" land holdings and makes trouble generally for the right-of-way department.

But when the rectilinear plan has been carried still farther and the land owners, to conserve particularly good areas for agricultural purposes, have had in times past enough influence to cause the county authorities to discontinue or vacate portions of ways along the section lines and have introduced right angled turns into the half or even quarter section lines, then the engineer has a task worthy of his mettle to secure a proper location for his improved road.

And if the road be in an orange grove section, his joy is indeed complete.

The writer knows of a main paved road in one of the California counties which has at least ten right angled turns in it in a distance of about 20 miles and this road passes through no town or city and is practically level. In planning their new highway system several years ago, that county gave up as hopeless the task of securing a direct route in the locality referred to, so for many years to come all through travel over those 20 miles of beautifully paved highway must be subjected to the dangerous right angled turns and to the unnecessarily increased length.

There is reason in cities and other centers of population for ways laid out in rectilinear fashion. In the open country, there is no excuse for planning a new highway system along such lines. Land should be condemned if the owners will not donate it.

There should be as direct a line between important centers as the topographical conditions will permit.

Assuming that the best alignment for the highway has been adopted, taking into consideration the factors of topography, climate and traffic needs, present and prospective, the next question confronting the highway engineer is the width of right of way.

It is certainly desirable that in any highway system the right of way be of uniform width, but as a practical matter each link in the system must be considered by itself. Near the centers of population it is obvious that the pavement and the rights of way must be wider than in remote rural communities, sparsely settled.

It is the writer's opinion, however, that for a minimum width of right of way 50 feet is none too much and that wherever possible, a width of 60 feet is the least that should be secured, even in sparsely settled localities.

It is inevitable that street railway, electric light and power, gas, telephone, and telegraph companies will at some time clamor for locations in the highway, and although too little attention has thus far been paid to the matter, tree planting and other landscape treatment of our country highways will have to be provided for.

In many of the older sections of the country right of way problems are not serious affairs. Ways have been established there, well defined and traveled, for many years, and right of way improvements consist chiefly in rectifying the side lines of locations where abutting land owners have encroached successfully under the "open adverse possession" statutes which apply in some of the states.

But in many localities, the acquisition of necessary easements of way becomes as important a factor in the plan and progress of highway work as the road work itself.

In the more sparsely settled communities, roads have been built following lines of least resistance, in the valleys the "sectionalized" land lines, and in the hills wherever the ranchers could best spare it. Accordingly, when modern road building methods are invoked, it becomes necessary to alter meandering and precipitous roads by straightening, widening, and improving the gradients. The needed rights of way for these purposes must be acquired.

This feature of the work is particularly annoying to the highway engineer. His desire is to press forward the best line in the best way in the best time. When he is confronted by a hostile, reluctant or indifferent land owner, the engineer usually loses his patience.

It is not alone in cases of new rights of way that there is litigation, but frequently old surveys do not exactly coincide with existing ways, many of which in course of usage have become winding and irregular, and consequently additional land has to be acquired to widen, straighten or alter them.

Owners often build fences or cultivate up to the used portion of the ways and resist the shifting of the lines and delay the progress of the work. In many cases much time is lost where owners who have allowed people to pass and repass in vehicles without objection for years, assert adverse claims and work must be delayed to avoid complications.

One has also the experience of attempting to use dedicated rights of way shown on plats recorded in times past but which have been entirely unused or allowed to fall into disuse, and then being confronted by claimants, with their attorneys, who contest the rights of the public therein.

*Read at Fourth American Road Congress, Atlanta, Ga., November 9-11, 1911.

Seawall on Rincon Route Protecting State Highway from Damage by Waves

Work is proceeding rapidly on the Rincon route, as the sea level sections of the State Highway between Santa Barbara and Ventura are termed. The attacks of the sea are being prevented in dangerous places by concrete sea walls to protect the highway pavement. The Rincon route will supplant the old Casitas pass, where several lives have been lost owing to the danger of the mountain road.

There are many unavoidable delays in obtaining rights of way, arising outside of the disputed rights of way mentioned. Even when the owners intend to be liberal they exact a great deal of information before signing the deeds of easement. The records have to be searched to ascertain the true owners of the lands affected; owners must be notified or corresponded with; draftsmen are asked to furnish sketches to many owners defining the rights of way desired; visits to the lands must be made and surveys inspected; minor adjustments of lines and fences must be settled upon; vacation proceedings arranged and prepared, abandoning the old roads or portions of roads over property so as to leave no incumbrance on the same when the new road is located and built; co-owners must consult among themselves before executing deeds of easement; ownerships involved in probate proceedings or title litigation must be searched and a good title to the roads acquired out of the confusion, and there are other details ad infinitum.

These many difficulties have led, in the writer's western experience in highway work, to the employment of the subtle right-of-way man, who needs be a psychologist as well as a philosopher. His chief duty consists in attempting to wheedle the often-times contrary land owners into signing the needed conveyances and to convince them, usually, that their duty to the public lies in giving their property gratis. Such an employee becomes a very important member of the organization. His troubles are many.

In addition to the "right-of-way man" and his assistants in the California work, the help and advice of an attorney learned in eminent domain practice has been had who devotes all of his time to the highway work and whose principal activities are in right of way matters. The writer takes this opportunity of acknowledging the assistance of Mr. Charles C. Carleton, attorney to the California Highway Commission, in the preparation of this paper.

In many jurisdictions, if the deeds can not be acquired by diplomatic methods, war must be declared in the courts, and the highway board must desist from its efforts to promptly furnish the community with necessary thoroughfares until the courts finally determine that the litigious land owners' holdings may be entered upon.

There is a great lack of uniformity in the different states in the methods of paying or securing the payment of damages in taking property for public highway purposes. Such methods are of course regulated entirely by the constitutions and statutes of the respective commonwealths.

In some states it is not necessary for the authorities to pay for private property taken for public use in advance of the actual taking of possession. The property owner has been provided with a method of making his claim and with a tribunal constituted so that he may enforce his claim and obtain his damages therein.

In such jurisdictions, highway work may speedily progress and the laying out of routes followed by immediate construction. The property owner, if he is dissatisfied with the original offer of payment or the award made to him by the public authorities, may pursue his remedy in the appropriate court even though his land has already been occupied by the public.

The public has the advantage of celerity in the progress of its enterprise; the land owner is protected by ultimate and adequate compensation for his injuries, and in one state, at least, he may wait until after the State Highway is completed before he must file his petition for jury trial, it then being evident to all interested parties just what damage has been done, not only by reason of the land taken but by the road construction as well.

But some states are so unfortunate as to be harassed in their public work by constitutions and statutes expressly requiring prepayment before entry upon the land required for puhlic use.

The writer has had to do with highway activities in two states which have operated under each of these methods, the one having the right to take land necessary for public use in advance of satisfying the owner; the other requiring that if the owner is not pleased with the offer made to him by the public authorities, he may stand back on his property with a shotgun and compel public officers to initiate proceedings in the court and remain off his property until after judgment has been obtained and the assessed damages paid into court for his use and benefit.

In the first mentioned commonwealth, the welfare and progress of the people as a whole are superior to the notions and eccentricities of an individual land owner.

In the other state, the recalcitrant land owner may oppose and delay the vital needs of a city, county or state, as the case may be, and his immediate rights predominate over the requirements of the community at large.

No rights of way, in states having regulations similar to the latter, can arbitrarily be taken by the people before the same, after a vast amount of red tape, have been acquired by donation, purchase or condemnation; that is, a taking can not be made and compensation and damages adjusted afterwards.

Consequently obstinate land owners are able to "hold up" the community at large until it either pays the demands or contests the question of compensation and damages in trials, the latter usually requiring considerable time, particularly in the case of the belligerent or indifferent land owners residing in other states or foreign countries when long publications of summons are necessary before the suits may be commenced. The western states appear to be particularly oppressed by such roundabout methods of entering upon private property and installing improvements for the benefit and welfare of millions of people.

For illustration, under such a system a large western land owner owning an area equal in size to an entire eastern state may be luxuriously traveling abroad. A county has voted and issued bonds for a large amount to construct important highways. Before the great ranch can be entered upon, except for surveys, a correspondence must ensue between the public authorities and the land magnate. The owner declines to sign a conveyance and the people are compelled to commence proceedings in eminent domain against the absent owner. Before a trial can be had, summons must be published for sixty days, and then follow the tedious court proceedings.

It usually happens that pugnacious land owners demand some exorbitant sum. The court may upon trial only allow a small percentage of their original claim but during the pendency of the action an important artery of travel may be debarred.

Such a system is absolutely hostile to progress; the people should be greater than the individual.

The writer submits that at this time, when modern highway construction is becoming so active throughout the nation, it is apparent that there should be simplification in the constitutions and statutes relating to the subject of eminent domain, and that this Congress may render invaluable service in assisting to bring about so desirable a result.

Too much attention can be given to the title technicalities of right of way activities. It has been an almost universal practice for public boards performing road work to obtain at great expense exhaustive abstracts of title to ascertain land ownerships.

The writer has had under his supervision the acquisition of hundreds of miles of highway right of way in California where the securing of rights of way could not be made much more difficult, complex or annoying, yet the purchase of expensive abstracts of title has been dispensed with. Out of hundreds of ownerships affected, not one serious complication has resulted from the following plan:

When the field parties are making the original surveys, the chiefs of party usually inquire from the occupants of the land surveyed who the owners or those interested in the property may be. This gives a clue to the ownership. Thereafter, one of the staff visits the proper county offices and ascertains from the assessment rolls or the records who purport to be the owners. Deeds or agreements are then prepared, containing the proper descriptions, and it is very rare, indeed, that any objection has been made to the accuracy of the instrument submitted.

By thus performing its own title searches, even though they may not have always been the most exact from a title lawyer's standpoint, the authorities have saved thousands of dollars and have never had an injunction or ejectment proceeding instituted against them by objecting land owners.

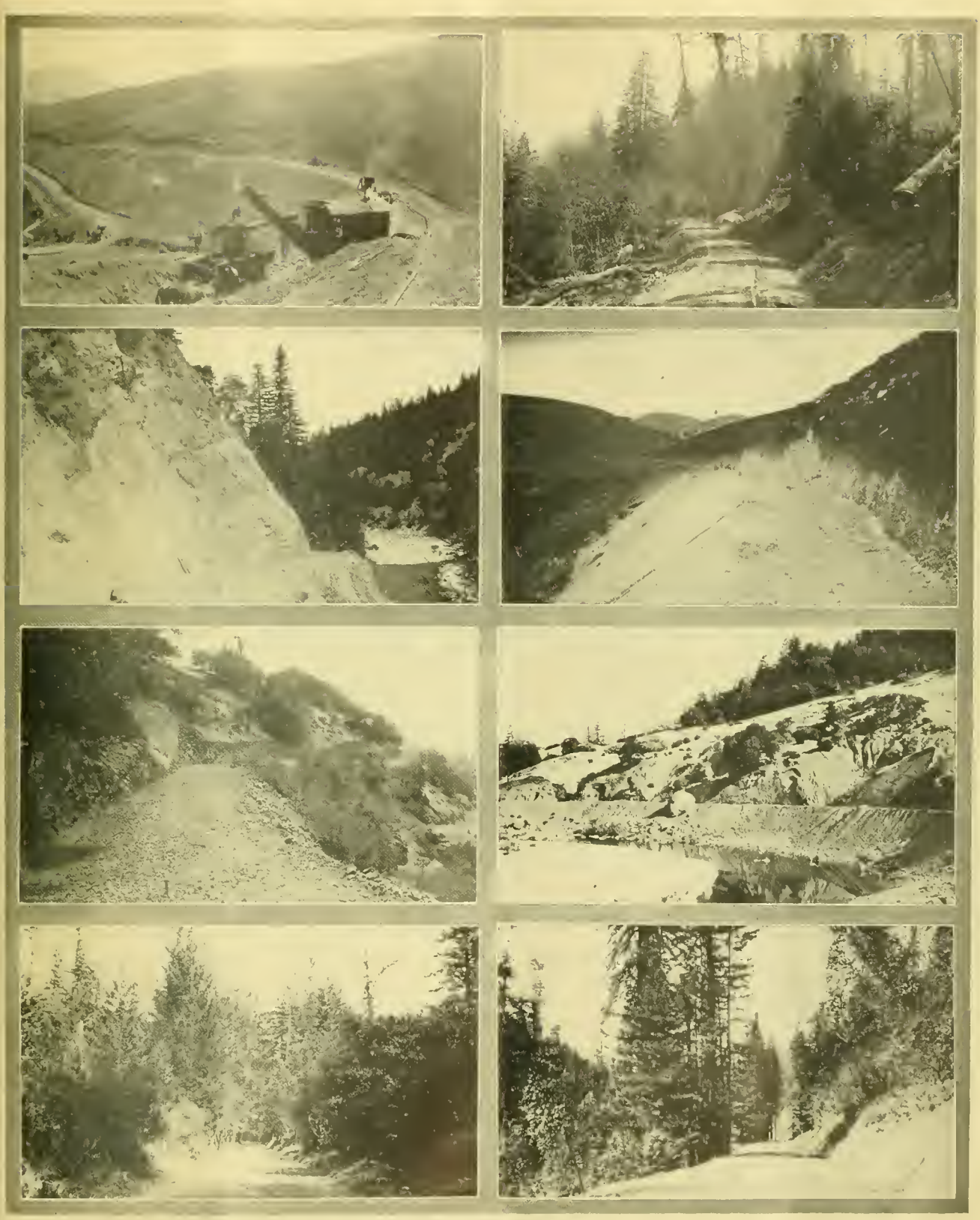
By taking a few remote chances of complaints, work, which would otherwise be hopelessly harassed and delayed in the performance of a highway project, may proceed.

Furthermore, in most states, title may be obtained two ways by user or implied dedication by the passage of time. It has been the custom in California where the present traveled roads are wide enough for use and properly located, to place the monuments and build the pavements and assert jurisdiction thereover, the theory being that if the owner objects, the authority's title being fundamentally weak, the state can "condemn" as rapidly as the alleged owner can "oust."

The so-called state highways in the several states may be divided into at least two classes with regard to the control by the state of the roads after they are built, namely, those which are maintained by the state and over which the state assumes complete charge from property line to property line with the possible exception of the policing of the way, and those sometimes called state-aid roads where the commonwealth has little or nothing to do with the maintenance of the roads and the burden is placed by law upon some subdivision of the state, usually the county.

The writer has had to do only with the class of state highways first mentioned and he believes that the state ought to have as complete control as possible over its highways, state or otherwise. Such control, however, places a considerable burden upon the authority which administers the law.

(Continued on page 15.)



Building Mountain Roads on California State Highway

BUILDING CALIFORNIA'S HIGHWAYS

Characteristics and Types of Roads in Systems Being Constructed under the Bond Issue of $18,000,000.

The following excerpts are from an article contributed by A. B. Fletcher, Highway Engineer, California Highway Commission, to a highway number issued by the Engineering Record, of New York, furnishing a summary of the building of the State Highway of California:

"California has been constructing a system of State Highways under a bond issue of $18,000,000 since the spring of 1912. The State Highways Act which controls the operations, defines roughly the roads to be built, although considerable latitude is permitted in fixing the exact locations. To comply with the law about 3,000 miles of road must be constructed. About 1,800 miles may be called trunk roads and the remainder laterals, or roads connecting county seats with the trunk roads.

"The trunk roads are sufficiently important to require paving to make them adequate at all times of the year. The laterals may, in general, be surfaced with gravels or other relatively inexpensive materials found near at hand.

"Early in the work it was determined that the roads built should have the following principal characteristics: (1) A right of way not less than 60 feet in width, where it is reasonably possible, and as direct between objective points as is consistently possible. (2) Gradients not exceeding 7 per cent, even in the mountainous parts of the state. (3) Curves as open as possible and in no case of less than 50 feet in radius. (4) As many culverts of sufficient capacity as are needed to take care of surface and underground water. (5) A traveled way, under ordinary conditions, not less than 21 feet in width, and in the mountains not less than 16 feet wide, with the center paved or surfaced so as to be hard and smooth under all climatic conditions at all times of the year, the width of surfacing to be in general 15 feet. (6) Smoothly graded roadsides, reserved for future tree planting.

"It is obvious that an appropriation of $18,000,000 for the construction of 3,000 miles of modern highways, or at an average rate of $6,000 per mile, is a very close if not an impossible figure. Even the engineering and administration expenses must be paid out of the $18,000,000.

"It was necessary, therefore, to eliminate all possible expenses and substantial savings were effected by requesting the counties to provide rights of way for the State Highways without cost to the state; requesting the counties to construct along the routes all bridges having spans in excess of 20 feet; omitting from the system all streets in incorporated cities and towns and placing the burden of their improvements upon the corporations; securing extraordinary reductions in freight charges on road materials used in State Highway work; making contracts with supply men for materials in large quantities at reduced rates, and supplying such materials to the contractors.

"The savings due to the elimination of the expenses above outlined amount to several million dollars, for in a most generous manner the requests of the state to the counties, incorporated cities and towns and the railroads were favorably received and granted almost invariably.

"In California, as in Massachussetts, the state controls the entire width of its highways from location line to location line in all matters except policing. Thus no street railways may be constructed or power lines or telegraph or telephone lines placed except under a permit from the department of engineering, nor may the roads be dug up for water pipes or sewers without its consent. It is necessary for this reason, if for no other, that the records of the highways be made very carefully and accurately, and extraordinary pains have been taken with the surveys and plans so that there may be no doubt in the future as to the rights of way. In addition, substantial concrete monuments are set at all angle points on both sides of the right of way, and at all beginnings and endings of curves and on long tangents in sufficient number to fix the lines. These features add much to the engineering cost of the project, but it is believed that the expense is amply justified.

"Before beginning operations, the principle was well established in the minds of those in control of the project that the paving of the trunk line highways should be so planned and constructed as to fit the traffic needs. In other words, it would be futile to adopt a rigid standard for the pavement and install it in all localities, regardless of the local conditions. Money would inevitably be wasted under such a policy, either because of unnecessarily high first cost or, if the pavement proved to be inadequate, enormous maintenance charges.

"The problem was reduced to a choice of three types of pavement possible under the conditions obtaining in California: (1) oil macadam pavement (penetration method); (2) concrete roadway with a relatively thin bituminous wearing surface; (3) concrete roadway with a thick bituminous top of asphaltic concrete.

"It was recognized that the water-bound macadam roads would not serve on the main lines of travel because of the preponderance of motor traffic.

"The brick pavement was not seriously considered as available because of the great cost of that type under California conditions. There are few, if any, suitable paving bricks made on the Pacific slope within a reasonable haul by rail and eastern brick would be enormously expensive.

"The asphaltic concrete pavement (Warrenite and its variants) unsupported by a cement concrete base was not considered so satisfactory as with the cement base and because there is little, if any, difference in cost in California between the 'black base' and the cement base.

"At the beginning of the work it was thought that for the major part of the paving the oil-macadam type would have to be adopted in all cases where the traffic was moderate in volume. Oil macadam, as it is called in the vernacular of the West, is substantially what is referred to in the East as macadam, penetration method.

"The going price for Portland cement was high and the price was closely controlled by the manufacturers. Two contracts, aggregating about 20 miles, were let for oil macadam pavements and the roads were built satisfactorily. The chances for failure in this kind of work, however, are many. It is difficult to secure suitable broken stone for this kind of work in many localities. The local gravels will not serve unless they are passed through a stone crusher and then they are often ill adapted to the work. It is difficult to control the quantity of asphaltic oil used and, all in all, the oil-macadam road in California, at the present writing, is not looked upon with much favor generally.

"To establish a market for Portland cement for highway work, the manufacturers after much parleying, agreed to reduce the price then obtained and established a maximum mill price, which they agreed to protect during the life of the State Highway work, thus permitting a much more general use of that commodity. Thereafter most of the highways were planned with a cement concrete base and a bituminous top, thick or thin as the character of the traffic seemed to dictate.

"In most cases where the traffic is moderate in volume—500 to 600 vehicles per day, at least one half of the vehicles being business or pleasure motors, with a fair sprinkling of wagons carrying from five to eight tons of produce—the concrete base with a bituminous top from one half to three eighths inch thick is being constructed. Indeed, although the writer decries the use of the expression, this kind of pavement has been called the standard type of the California State Highways.

"In general, where the subgrade is firm and hard and likely to stay so, or where the subgrade can be made to conform to such requirements, the concrete base is but four inches in thickness. There seemed to be ample precedent in the mind of the writer for a base so thin as four inches in certain eastern construction of which he had knowledge, and certainly if such a base is sufficient in the frost-bitten East, there would be little doubt of its adequacy in sun-kissed California. The experience of more than two years has proved the suitability of the four-inch concrete base under the conditions mentioned. There have been no failures even under extreme traffic. The writer does not wish to be understood as favoring a base so thin except under ideal conditions of subgrade with a total absence of frost conditions. The concrete must be honestly made and laid and reasonably rich in cement.

"In the California work the concrete closely approximates a 1:2:4 mixture and it is carefully inspected in all stages. The materials are usually purchased by the state and delivered to the contractors. The cement is invariably handled in this way. When the concrete must be laid over adobe or other bad material the base is thickened to five or six inches.

"Another somewhat unusual feature in the California work is the omission of expansion joints. All of the concrete base is covered with a wearing surface of asphalt, thick or thin. It is notorious that all concrete pavements crack, whether because of contraction, expansion or absorption of moisture. Many learned members of the profession are still seeking the reasons, for they are probably diverse, in an endeavor to minimize the cracking. It is equally notorious that concrete pavements will crack in a most perverse manner, and they do not always open solely at the artificial joints. The bituminous covering, in California, seems to fill such cracks as develop, and there has been but little if any trouble from such cracks.

"There have been cases, however, in the hot central valley, with midsummer temperatures at 110 degrees Fahrenheit or more, where the concrete has buckled. The writer is familiar with one section about ten miles long which has sixteen buckles, due, beyond doubt to the expansion of concrete. It is possible that a few joints in that ten-mile stretch, filled with asphaltic material would have prevented the buckling. Such cases, however, are few and far between in the California

work and by no means suggest the need of a radical change in policy as to the non-installation of expansion joints.

"There has been much said in California concerning the thin bituminous wearing surfaces which the state has employed so generally. The state is fortunate in having within its borders a vast supply of oil with an asphaltic base. This oil, or most of it, is so heavy in its natural state as it is pumped from the ground, that it is better adapted for making asphalt and fuel oil than it is for manufacturing kerosene and gasoline. The California asphalts, as now made, have become well and favorably known all over the United States. It is because of the excellence of the asphaltic oil which has been secured that the thin top has been so successful on the State Highways.

"The oil is purchased by the state in large quantity after competitive bidding on carefully prepared specifications. It is tested from time to time as the storage tank is filled, and it is known before shipment to the work that the oil is satisfactory. For the thin top work, an oil carrying about 90 per cent of bitumen is now considered the best adapted for covering the concrete, but under certain conditions, oils in excess of 95 per cent have been used successfully.

"There is no essential difference between this coating and the bituminous carpets which have been used for eight years or more in protecting macadam roads from the ravages of automobiles. It seems likely, however, that because of the excellent oil in California the coating will have a longer life than the bituminous carpets applied in the East.

Building the State Highway Through Northern California Forests

"The earliest work of this sort on the California State Highways was done near Fresno about twenty-three months ago. There is hardly any wear appreciable at this time on this surfacing and there is every indication now that the bituminous covering, in that locality at least, will have a life of at least four years with little or no expense for repairs.

"Near San Francisco and running southerly to San Jose, about fifty miles distant, the traffic is very great in volume and the paving has been made wider and the wearing surface thicker than is usual in the less populous regions, the paving varying from twenty to twenty-four feet in width.

"In some places, where this stretch had been previously macadamized, the old roadway was used as a base for the new road and the asphaltic top, about one and one half inches thick, was placed upon the old macadam after considerable labor and expense in smoothing and re-rolling. It was usually found, however, that the old macadam was so worn that it cost excessively to make it suitable and to receive the asphaltic top and it is probable that a cement concrete base would have been nearly as cheap and the results would certainly have been better.

"In general, where the traffic is heavy, a wearing surface of one and one half inches of asphaltic concrete has been placed over an adequate cement concrete base, the top and the base being united by a paint binder of asphalt and gasoline or distillate, applied hot to the cleaned concrete base.

"For the asphaltic top, Warrenite, Topeka mixture and sheet asphalt have all been used, apparently with excellent results."

Savings From Good Roads

Orange County in Southern California has supplemented the State Highway by the construction of 107 miles of paved roadway. When Sonoma County decided to consider a system of highway improvement, the secretary of the Sonoma County Good Roads Club wrote to Col. S. H. Finley, a leading tax payer of Orange County and County Highway Engineer, regarding the saving effected by good roads in that county. Colonel Finley said in reply:

"Assuming that your bonds bear 5½ per cent interest and extend over a period of thirty-two years payable $50,000 each year, your payments will average $91,250 per year for bonds and interest. How will you pay this? I will answer that you can do it in several ways and be richer after the debt is wiped out.

"1. The assessed valuation of non-operative property in your county last year was $37,000,000. The value of all this property will be increased by at least ten per cent by the construction of 163 miles of good roads. Assuming that your tax rate is $1.70, this increase will yield you about $60,000 annually without increasing your rate, or enough to pay the interest and one third of the bonds. Or, the immediate increase in valuation will be more than sufficient to pay the entire bond issue and interest for thirty-two years.

"2. The saving on depreciation, repairs and fuel for automobiles will average at least $110.00 each per year. Assuming that you have 2,000 motor vehicles of all kinds in the county, the savings to the owners of these will annually amount to $220,000, or enough to pay off the entire bond issue with interest twice over.

"3. Assuming that you have 5,000 horses and mules in your county, the goods roads will save at least:

For shoes and harness annually, $1.50 each	$7,500
For each animal for feed, 50 cents per month	30,000
Increase useful life of each animal, 10 per cent	75,000
Wear and tear on wagons and carriages, 2,000 at $5.00 each	10,000
Total	$122,500

"This will be sufficient to pay the bonds and interest for thirty-two years and have an annual surplus of $32,500 to expend on maintenance.

"4. United States census figures show that it cost Sonoma County $180,000 per year more to haul over its present roads than it would over improved roads, and this item alone would more than meet the annual payments on bond and interest.

"5. The advertising feature alone would be worth enough to cover the $40,000 average annual interest. Your neighboring counties will doubtless make permanent road improvement, and if you do not, the results will be that people touring through the state will be advised to go around Sonoma County. You can not afford to permit that.

"Our good road system in Orange County is nearing completion and, judging from its effects already evident, I am convinced that the above figures are not the result of an idle dream."

A California Concrete Road

By James B. Woodson
Division Engineer, Division VI, California Highway Commission.

A portion of the San Joaquin Valley artery of the State Highway which has been constructed and under traffic for a longer period than any other section, is a 9.55-mile piece extending northwesterly from the city of Fresno to the banks of the San Joaquin River.

The contract for the construction of this road was let in August, 1912, to the Worswick Street Paving Company of Fresno. The laying of concrete pavement was begun in October, 1912, and the completion of concrete was in April, 1913.

The system used in throwing open a section of pavement to traffic is that after the concrete has reached an age of 21 days, if a side road be conveniently handy to divert the travel away from the new operations, the concrete is cleaned off, a barricade placed at the diversion point and all types of vehicles are permitted thereon.

The pavement consists of a four (4) inch base of Portland cement concrete, 15 feet wide, covered for the most part with a one half (½) inch wearing surface of asphaltic oil and broken stone screenings or coarse sand, and has a crown rise of 2¾ inches. In addition, 3 foot shoulders widen the width of traveled roadway to 21 feet.

Recognizing the fact that a firm foundation is one of the first and most important principles of good engineering as applied to road construction, the contractor was required to plow or scarify the existing roadway and after pulverizing and cultivating the broken up portion, to thoroughly wet and roll to the greatest possible compactness.

In this way a subgrade was secured which showed no perceptible movement under a ten ton road roller.

In order to secure water for wetting the subgrade and concrete, wells were drilled at convenient points and connected with a 2-inch pipe line. Wherever irrigation canals or old wells were not available new wells were bored and the water pumped through the pipe line up to a distance of approximately one mile on each side of the pumping station. In this way sufficient water was secured for settling the subgrade, mixing and placing the concrete and keeping same wet for the required period of six days despite the prediction of outside parties that a concrete base for country roads in as warm a section as the San Joaquin Valley would not be practicable owing to the impossibility of economically handling the water question and of keeping the concrete moist until thoroughly cured.

The contract for grading was on a mileage basis though the present policy of this Commission is to prefer the yardage basis.

The contract price was $900 per mile or 10.2 cents per square yard of concrete pavement.

After the roadway was graded and thoroughly watered and rolled, timber headers of 2-inch by 4-inch planks placed on edge and securely nailed inside of supporting stakes were placed along the outside for pavement forms. These headers conformed to the lines and grades of the edge of the finished pavement and the subgrade was then shaped to the finished grade of the bottom of the concrete by a wooden template, the bottom of the template conforming to and approximately 4 inches below the finished crown of the concrete. By "approximately" is meant that the subgrade was usually finished a little above the final grade, depending upon the nature of the material forming the foundation, and the final rolling and wetting compacted the dirt to the desired grade.

The grade was then kept clean and thoroughly wet immediately in advance of the concrete to insure obtaining a full 4 inch thickness and to prevent any of the water in the concrete being absorbed by a dry subgrade.

A 1:2½:5 mixture was used for the concrete, which when properly mixed with clean and well graded material has proven to be perfectly satisfactory. This requires on the basis of 45 per cent voids 1.3 barrels of cement to the cubic yard of concrete.

A Foote two third cubic yard mixer was used throughout, and the concrete was mixed with just enough water to be of a jelly-like consistency, care being taken not to have the mixture so wet that the mortar would flow away from the coarse aggregate, with a resultant "lean" mixture.

After being placed, the concrete was struck with a template riding on the header boards, and was followed up sufficiently close with wooden tampers and smoothed with a wooden float, there being sufficient roughness on the finished surface to insure cleavage of the oil wearing surface.

The construction of a 4-inch satisfactory pavement demands practically no leeway in any departure from the specifications. Coarse aggregate for concrete that runs a high percentage of materials passing a one inch screen requires an excess of sand to get the finish and therefore makes a weaker mixture of concrete than the specified quantity of sand. Also too much material in the coarse aggregate passing a ¼ inch screen again reduces the quality of the mixture due to the fact that sufficient tests can not be made rapidly enough to adjust the sand at the mixer.

The coarse aggregate on this contract was entirely of clean gravel from the Friant pit. The gravel was well graded from ¼ inch up to 2½ inches. The sand was also from the same source; great care being taken to eliminate the clay dirt that was mixed with the sand at the pit.

Frequent tests were made both in the Division office and by the resident engineers on the work to determine the amount of objectionable material in the aggregate. Material that tests over 6 per cent by weight in material passing a 100 mesh screen was considered not satisfactory. This part classified as silt.

The cracks appeared at fairly regular intervals of from 25 to 35 feet. However, no bad results have been occasioned by reason of these cracks, as the first concrete laid was open to traffic *seven* months before the oil surfacing was applied and on this section there was no perceptible breaking down or disintegrating of aggregate.

With the oil surfacing complete and the concrete now close on to two years old, it would be a comparatively hard matter to locate the cracks unless one were making a special search.

Concrete was run during 104 days or an average of 484 lineal feet per day of concrete run. On 24 days out of the 104, over 700 lineal feet were made, and on six days the daily progress was over 800 lineal feet. The highest run for any 8 hours was 857 lineal feet with the following crew:

1 Foreman	$4 00
1 Engineer	3 50
1 Water tender	2 00
1 Chute man	2 40
4 Chute men at $2.00	8 00
11 Wheelers and shovelers at $2.00	22 00
1 Wheeler	2 25
2 Men handling planks at $2.00	4 00
2 Men smoothing concrete at $2.00	4 00
1 Man tamping	2 00
1 Man brooming	2 00
2 Men handling cement at $2.00	4 00
1 Wagon spotter	2 00
1 Two-horse wagon and driver (handling boards)	4 50
1 Man helping (handling boards)	2 00
1 Concrete mixer, fuel, etc.	5 00
1 Pump and engineer	6 00
33 Men, total on concrete work	$79 65

857 lineal feet = 158.7 cubic yards = $0.503 per cubic yard or 5.6 cents per square yard of concrete 4 inches thick.

The total cost of this 9.55 miles of road, covering grading and concrete base, and including cost of cement, was $49,359, making a price of $5,168 per mile or $0.587 per square yard of pavement.

In order to determine an adaptable wearing surface that could economically be applied, two types were placed on this section.

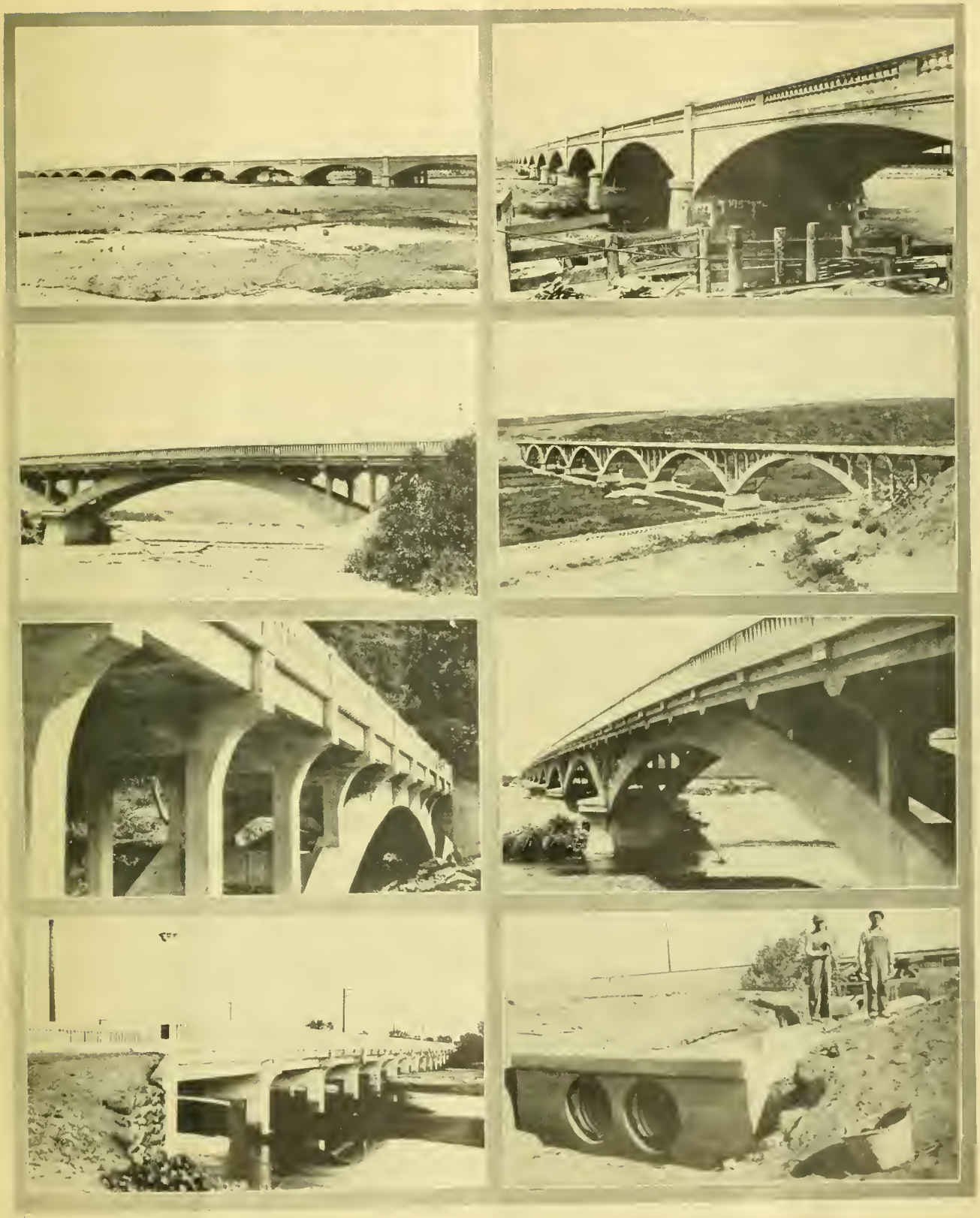
One was a mastic mixture consisting of a composition of approximately equal parts of asphaltic cement, 70 to 80 penetration, and powdered lime rock spread to a thickness of ⅜ inch, on top of which, after laying, was spread broken stone screenings or coarse sand as needed to absorb the excess of bitumen as it appeared on the surface or as the mixture softened under the heat of the sun.

The other surfacing consisted of an application of approximately ½ gallon per square yard of asphaltic oil spread at from 250 to 300 F. containing 90 per cent of 80 penetration asphalt, on top of which was spread sufficient sand or screenings to absorb the oil. Approximately 0.488 gallons of 90 per cent asphaltic oil per square yard and 260 tons of screenings per mile making 0.03 tons per square yard, making a final thickness of slightly less than ½ inch.

Summary of Costs.

	Total cost	Per mile	Per square yard of concrete
Grading	$8,591 40	$900 00	$0 102
Concrete base (including cement)	49,358 92	5,168 48	0 587
Bituminous surfacing (including mastic)	7,730 19	809 44	0 092
Culverts, monuments, guard rail, etc.	820 32	809 44	0 009
Totals	$66,500 83	$6,963 82	$0 790

In conclusion the writer wishes to state that it is now lacking a few days of being two years since the first portion of this road was thrown open to traffic; and with the exception of slight maintenance on oil surfacing and dirt shoulders, there has been no failure of any nature observed in the pavement.



Type of Bridges and Culverts on California State Highway

Asphaltic Concrete

By A. E. Loder

Division Engineer, Division IV, California Highway Commission.

Asphaltic concrete is used to designate a concrete in which a bituminous substance serves as the cementing agent for the mineral aggregate of various sizes.

The word concrete in its earlier application to cement concrete implies a mixture in which the voids of a coarse aggregate are filled to a slight excess with a finer aggregate and the mass bonded with cement in such manner that the coarse pieces are in substantial contact. As the word concrete is now carelessly used in connection with bituminous materials, it is sometimes applied to a mixture in which the coarse material is a very small percentage of the fine, giving the effect of a fine aggregate with scattered pieces of coarse aggregate floating freely within it.

The three types of hot mixed asphaltic surface in most common use are Standard sheet asphalt, Topeka mixture, and asphalt concrete known under the proprietary names of "bitulithic" and "Warrenite."

In order to compare them more closely they will be discussed in order.

Sheet asphalt, commonly known as "standard surface," should be laid as closely as the available materials will permit to the grading known as the New York standard, with variations to meet climatic conditions and to provide for heavy traffic or for light traffic. The following tabulation gives in the first column the average grading from 68 tests covering the entire 5.4 miles of standard asphalt surface as laid one inch thick on Contract No. 1, and the second column gives the grading known as the New York standard for heavy traffic:

	Average 68 tests on Contract No. 1	New York standard heavy traffic
Penetration	90	
Bitumen	10.66 per cent	10.5 per cent
Passing 200 mesh	13.94 per cent	13.0 per cent
Passing 100 mesh / Passing 80 mesh \	25.85 per cent	26.0 per cent
Passing 50 mesh	25.23 per cent	23.5 per cent
Passing 40 mesh	9.46 per cent	11.0 per cent
Passing 30 mesh	5.45 per cent	8.0 per cent
Passing 20 mesh	6.77 per cent	5.0 per cent
Passing 10 mesh	2.64 per cent	3.0 per cent
	106.04 per cent	100.0 per cent

Comparison shows that Contract No. 1 was laid as near the standard grading for heavy traffic as possible to proportion.

The most important feature of proportioning standard asphalt mixture is to secure the proper percentage of the finer sands passing the 80 and 100 mesh screen and then to use the correct amount of rock powder and bitumen. In fact this principle holds for any successful asphalt pavement.

The specifications for the so-called Topeka mixture which is now being laid on this division were prepared by using the standard sheet asphalt grading and scaling the proportions down to 75 per cent to admit 25 per cent of coarse aggregate or grit between the 10 mesh screen and ½ inch. This provides for a much more uniform and dense pavement than would be permitted under the original Topeka specifications. The former Topeka grading permits the use of either coarse or fine sand at the contractor's discretion.

The proprietary bitulithic or Warrenite pavement is more truly asphaltic concrete than the Topeka mixture. It was formerly known under the name "bitulithic," which was an asphalt concrete laid upon a crushed rock base which had been grouted with bituminous material. Later, a slight variation was put ont under the name "Warrenite" to meet the requirements where a cheaper surface was required. The two terms are now used more or less interchangeably. Both may be laid with either a bituminous or a cement concrete base. For a time, two or three years ago, the proprietors permitted the use of gravel aggregate under the name of Warrenite. Recently they opposed the use of gravel aggregate under either brand. The only apparent difference now between bitulithic and Warrenite is the use of the term Warrenite when a relatively thin wearing surface is to be laid, in which the maximum size of rock is 1¼ inches and the use of bitulithic when a thicker or more expensive surface is to be laid, in which case rock may be used up to 1½ inches. It is the general practice to limit the size of rock to one half the thickness of the wearing course.

The following grading is used for a bitulithic surface in the city of Los Angeles under Specification 99:

Passing 1½-inch mesh	10-15 per cent
Passing 1-inch mesh	26-35 per cent
Passing ½-inch mesh	12-20 per cent
Passing ¼-inch mesh	8-12 per cent
Passing 10 mesh	24-32 per cent
Passing 200 mesh	4- 7 per cent
Bitulithic waterproof cement	7-9½ per cent

This calls for the use of from 56 to 82 per cent of coarse aggregate.

The following extract from a general specification for bitulithic embodies the claims of the promoter as to the merits of the pavement: "In the mixer bitulithic cement shall be added in sufficient quantities to coat all particles and fill such voids as remain unfilled by the proportionment of the mineral aggregate. The aggregate shall be so proportioned as to secure in the aggregate inherent stability, density, freedom from voids, and resistance to displacement, and a mixture which when combined with the bitulithic cement and compacted together, will form a bituminous street pavement structure containing mixed mineral ingredients of such grades as to give the structure inherent stability."

When laid strictly in accordance with the above specification, the pavement should give excellent results on a good foundation. However, like every other type of surfacing, poor work can be laid if not properly supervised. The "inherent stability" is secured more by the material passing the 80 mesh screen than by the rock.

When laying a Topeka surface, we require the asphalt plant to be so equipped that the rock powder, the hot asphaltic cement, the hot sand and the hot aggregate between 10 mesh and ½ inch can be weighed separately into each batch or box which totals from 900 to 1,000 pounds. A skilled inspector is required at the plant to take temperatures of each load and of the hot materials, and to see that the materials are properly combined. A skilled assistant is required where the prepared asphalt mixture known as "hot stuff" is delivered and incorporated into the pavement. The load must be dumped on the foundation sufficiently ahead of the spreading that it will all be shoveled over by the hot gang before it becomes a part of the surface. The mixture must be thoroughly raked out to the bottom and spread with uniform density and thickness, to reduce to a minimum the small undulations which appear after rolling.

The process of mixing and placing standard sheet asphalt is the same as for the Topeka, except that the coarse aggregate is omitted.

When sands impregnated with a natural bitumen such as the product known as "Santa Cruz bitumen" is used on either Topeka or Standard asphalt work, the process on the street remains the same, but the plant work is very different. A batch is made up by weighing and proportioning separately in wheelbarrows, the following ingredients:

Rock powder;
Coarse or soft bitumen;
Fine or hard bitumen;
A small amount of Antioch sand;
And the coarse mineral aggregate if desired.

The cold ingredients are fed into a revolving cone-shaped drum known as a torpedo mixer. Heat is applied to the outside and the materials thoroughly mixed and cooked for about fifteen minutes, while passing to the discharge end.

The trouble with this process is that the output is limited and the work slow. It is difficult with such a plant to secure uniform temperatures. The continued cooking during the process of mixing gives the product some advantage over material prepared in the standard plant.

The Santa Cruz bitumen contains a natural asphaltic cement which is very tough and ductile and of higher penetration than the manufactured product. From our observations thus far it appears possible to construct an asphaltic surface with this natural bitumen which will equal and probably excel pavements containing the manufactured product. It has been used with indifferent results for many years, but only recently has it been treated and combined in a scientific manner, giving satisfaction. During the past season we have found it possible to secure more uniform grading from day to day than where the best available sands were used with manufactured asphalt.

The thickness of a hot mixed asphalt surface should not be less than 1½ inches. It was difficult to spread and rake Standard asphalt as thin as one inch; in fact it required the materials for an average of nearly 1¼ inches. The hot mixture cooled so rapidly that it was difficult to properly place and roll it so thin. It should not be undertaken except during very warm weather, and then is of questionable economy. The thin surface requires the same expense for placing as if it were laid 1½ inches thick. When sheet asphalt has worn down to an average of one half inch it needs replacement. On such a basis it is readily seen that for fifty per cent more material, and possibly twenty per cent more labor, one hundred per cent more available wearing thickness can be had.

A paint binder composed of 80 penetration paving asphalt, dissolved in from one to one and one half times its volume of No. 1 engine dis-

Cautionary Signs Used in State Highway Construction

tillate, has been used successfully on all of the asphalt surface work laid upon concrete base in this division.

The asphalt is heated at the roadside in a portable kettle. A measured quantity is placed in a mixing pail at a safe distance from the fire and the distillate added. It is then poured on the concrete from buckets and swept ahead in a light wave with house brooms. The painted surface is immediately swept over a second time to remove excess paint from depressions. It should be applied only when concrete is thoroughly dry.

The paint should be so proportioned that after evaporation there will remain a thin film of asphaltic cement having a bright, glossy black surface and penetrating into the concrete for perhaps one thirty-second of an inch.

On Contract No. 1 where the paint was used on 5.4 miles, the cost per square yard as applied by force account was as follows:

0.095 gallons distillate at .085 per gallon, delivered on the job	$0.0081
0.344 pounds asphaltic cement at $9.76 per ton, delivered on the job	.0025
Labor at $2.50 per day to $3.00 per day of 8 hours	.0067
Plus 15 per cent on labor	.0010
Total cost per square yard	$0.0183

The paint binder gives such a positive bond that the concrete is torn away when the asphalt is removed. It prevents slipping of the surface. It waterproofs the under side of the asphalt and prevents it from being attacked by water, which is so often found to sweat through the concrete and appear in small drops in the under side of the asphalt. It also prevents water from entering between the asphalt and the concrete and seeping along between them down long grades, raising the asphalt away from the base.

On the one inch standard asphalt on Contract No. 1, the asphalt is so tightly bonded to the base that whenever the concrete cracks the asphalt surface is forced to crack immediately above it, instead of stretching over the crack, as it does where the binder is not used. This can not be held as a disadvantage since it is desirable to know where the cracks are located in order that they can be poured full of waterproofing asphalt from the surface.

Considerable waterbound macadam base was constructed for carrying asphalt surface during the past year. It is believed that good results have been obtained, but that it will not be economical or desirable to attempt further work of the same class. It had been expected that a considerable portion of the old macadam could be used, but it was found so thin that substantially a new macadam base became necessary. It was found best to compact the 5-inch concrete base in one course of large rock or in two courses with the larger rock at the surface. It was thoroughly bonded by rolling and screening until it appeared as hard and unyielding as concrete. Excess screenings were broomed out, leaving a clean surface of projecting pieces of angular rock. This gave a good mechanical bond which proved to be essential.

During the early part of the winter it was found on two jobs that rising ground water weakened the macadam base and permitted the asphalt surface to crack from the under side until it showed through to the surface in irregular concentric rings about the weak spot. Such trouble occurred in only a few minor places and was promptly repaired by the contractors, even though they had completed the work. However, the lesson to be gained from it is that concrete base is better than macadam base, or any type of flexible base, for carrying asphalt surfacing wherever there is a possiblity of rising ground water.

Water-holding soils contain a large percentage of plastic clay. As the water increases, the stability of the soil decreases, due to the lubrication, until the mass approaches the state of a liquid, offering little or no resistance to change in shape. When the pressure increases or concentrates at any point, the material flows until it reaches a state of equilibrium. Such material, whether partially or wholly saturated, would never be displaced by the heaviest loading were it possible to confine it and maintain the pressure uniformly on all sides.

Where rising ground water causes an unexpected soft spot under a completed pavement, a rigid cement concrete structure is better than a flexible pavement. The rigid slab floats or distributes the heavy concentrated load over a much wider area than the flexible surfacing. The unit pressure on a yielding subgrade resulting from a concentrated load applied to the pavement varies inversely as the square of the span over which the pavement is acting as a beam. This great reduction in the unit pressure and its uniform application over such a wide area when cement concrete is used, serves to confine saturated places, reducing the possibility of its displacement. If the soft spot is small, a rigid pavement will bridge the load to the hard material on either side.

The argument is often advanced that a flexible pavement like asphalt concrete is better than cement concrete over soft ground or new fills, because it will conform with any irregularity or subsidence without cracking. The writer's observation convinces him that such argument is the very reason why it is inferior to cement concrete for such conditions; but there is no objection to asphalt concrete base where drainage is adequate and uniformly good support is to be had. Concrete will conform with any general settlement, as on new fills, without unusual cracks, while it will bridge over and equalize the pressure where soft spots develop, thereby preventing an undulating surface with its unpleasant riding qualities.

Rights of Way

(Continued from page 8.)

More is expected of a state organization, and rightly so, than of a county board. Its work must be done carefully and accurately. The surveys and plans of the state highways must be well made and no small part of the engineering costs is chargeable to the careful work needed in running out and establishing the right of way lines.

In trying to establish old right of way lines in anticipation of highway improvements, much difficulty is often experienced in finding any landmarks to indicate what the right of way really is, and the old surveys and plans often prove to be of little assistance. Often the roads to be taken over and built as state highways were laid out when the land was of little value and the surveys were carelessly made or the descriptions carelessly recorded. With the lapse of time buildings, trees, and other similar features, which formerly marked the location of the road, have entirely disappeared, and the traveled ways have shifted from place to place as the action of the elements or the whims of the travelers have directed. Fences, if they exist, have been so moved about that they in no way indicate the original line of the road.

In all state work with which the writer has had to do it has been the policy to fix the right of way lines on the ground by setting proper monuments into the soil to such a depth that they serve as markers for all time to come.

In planning a new system of highways, careful plans should be made and permanent monuments set. Future generations will surely appreciate such records and the additional cost of this kind of work should not forbid.

California Highway Commission's Specifications for Road Oil

(*a*) The oil shall be a natural oil with an asphaltic base, treated to remove water or sediment or the residuum of such an oil from which the volatile material has been removed by distillation, and shall be satisfactory to the Engineer. It must not have been injured by overheating, and it must not be obtained by adding solid asphalt to lighter oils or distillates.

(*b*) In determining the quantity of oil delivered, the correction for expansion by heat shall be as follows: From the measured volume of oil received at any temperature above sixty (60) degrees Fahrenheit an amount equivalent to four tenths (0.4) of one (1) per cent for every ten (10) degrees above sixty (60) degrees Fahrenheit shall be subtracted as the correction for expansion by heat. For the purpose of measuring oil, a temperature of sixty (60) degrees Fahrenheit shall be deemed a normal temperature.

(*c*) Deduction will be made for water and sediment in exact proportion to the percentage of water and sediment found therein, and the oil shall not contain over two (2) per cent of such water and sediment.

(*d*) After being freed from water and sediment, the oil shall contain not less than ninety (90) per cent of asphalt, having at a temperature of seventy-seven (77) degrees Fahrenheit, a penetration of eighty (80) degrees District of Columbia standard. The percentage of asphalt shall be determined by heating twenty-five (25) grams of said oil or residuum in an evaporating oven at a temperature of four hundred (400) degrees Fahrenheit until it has reached the proper consistency, when the weight of the residuum shall be determined and the per cent calculated.

(*e*) The oil shall show an adhesive strength of not less than three hundred (300) seconds when tested at a temperature of seventy-seven (77) degrees Fahrenheit by the Osborne Adhesive Test Apparatus at the laboratory of the California Highway Commission. The oil shall show a specific viscosity of not more than one hundred (100) when tested with the Engler viscosimeter at a temperature of two hundred and twelve (212) degrees Fahrenheit.

(*f*) Residuum shall not contain in excess of two tenths (0.2) of one (1) per cent of organic matter insoluble in carbon tetrachloride at ordinary temperature, after the removal of the percentage of water and sediment.

GENERAL REQUIREMENTS.

The asphaltic oil is to be stored in a tank or tanks held for the California Highway Commission. A representative of the California Highway Commission will take samples of this oil as the tank is being filled. The tank will be sealed and held until the tests are completed.

When the tests show the oil to satisfy the above specifications for oil, it can be drawn on, subject to the orders of the California Highway Commission.

The oil will be kept under seal and this seal broken and oil car loaded under the inspection of a representative of the California Highway Commission.

The asphaltic oil is to be shipped in tank cars of standard measurement loaded to gallonage capacity, such cars to be properly equipped with tight steam coils that do not permit any leakage of water or live steam into the oil. It is understood that the unit of measurement, the barrel, contains 42 United States gallons of 231 cubic inches each.

In general the improved width of the completed State Highway on the main routes where the concrete pavement is placed is 21 feet. Many travelers who ride over the concrete pavement before the surfacing and shoulders are placed regard the pavement as finished work and consider it too narrow. The rock shoulders placed on either side of the concrete make the improvement six feet wider than the concrete section of the road, giving ample clearance for passing vehicles at the maximum speed permitted by law.

The Highway Bulletin is designed to present a report of progress on California's State Highways, and, in connection therewith, matters allied with Highway construction and growing out of the progress of the work, and is sent free of charge to those interested in the State Highways. It is published only as occasion justifies, and the present number is the fourth to be issued since organization of the California Highway Commission. Nearly all the State Highway departments of the United States issue bulletins in magazine form, which is found the most desirable means of presenting the work to the public. That of the Iowa Commission reaches a monthly circulation of 20,000.

Trestle of Rincon Causeway Coast Route of State Highway

RECORD OF PROGRESS OF THE STATE HIGHWAY

State Highway Routes

The routing of the State Highway is not entirely optional, as certain mandates of the State Highway Act must be followed. The act makes the following provision as to routes: "The route or routes of said State Highways shall be selected by the department of engineering and said route shall be so selected and said highways so laid out and constructed or acquired as to constitute a continuous and connected State Highway system running north and south through the state traversing the Sacramento and San Joaquin valleys and along the Pacific coast by the most direct and practicable routes, connecting the county seats of the several counties through which it passes and joining the centers of population, together with such branch roads as may be necessary to connect therewith the several county seats lying east and west of such State Highway."

The routes already established for the State Highway are naturally related first to the system traversing the valleys and along the coast and joining the centers of population. These have all been designated, surveys practically completed and work well advanced, and the Highway Commission is now working on the problem of the best branch roads to connect the county seats not passed through on the main system.

The following figures include surveys only, and do not comprehend mileage through incorporated cities or improved highways in county systems, as in Sacramento, San Joaquin and Los Angeles counties, not yet taken over as part of the State Highway. Hence the mileage given represents State Highway surveys or construction, only, and not the total number of miles between the terminals indicated.

The surveys made to December 15, 1914, aggregate 2,062.84 miles. The work completed or under contract to the same date totals 1,036.3 miles. One hundred and fifty-four layouts have been finished, totaling 1,108.1 miles.

Routes already established and the counties through which they pass are as follows:

ROUTE 1, along the Pacific coast north of San Francisco Bay, through Marin, Sonoma, Mendocino, Humboldt, and Del Norte counties. Length, as surveyed, and with surveys ordered, 381.2 miles; completed or under contract, 111.6 miles.

ROUTE 2, along the coast south from San Francisco to San Diego, through San Mateo, Santa Clara, San Benito, Monterey, San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange and San Diego counties. Length, exclusive of county highway in Los Angeles County, as surveyed 464.6 miles; completed or under construction, 302.3 miles.

ROUTE 3, through the Sacramento Valley, from Sacramento to the California-Oregon boundary line, through Sacramento, Placer, Yuba, Sutter, Butte, Tehama, Shasta and Siskiyou counties. Length, as surveyed, 277.6 miles; completed or under construction, 158.5 miles.

ROUTE 4, through the San Joaquin Valley, from Sacramento to Los Angeles, through Sacramento, San Joaquin, Stanislaus, Merced, Madera, Fresno, Tulare, Kern and Los Angeles counties. Length, as surveyed, 270.8 miles; completed or under construction, 211.1 miles.

ROUTE 5, from the San Joaquin Valley system to Santa Cruz via Oakland and San Jose. Length as surveyed, 92.2 miles; completed or under construction, 55.7 miles.

ROUTE 6, from Sacramento across the Yolo by-pass to a connection with route 7 near Davis. Length, as surveyed, 14.5 miles; under contract, 3.1 miles.

ROUTE 7, from Tehama Junction to Benicia, connecting the county seats of Glenn, Colusa, Yolo and Solano counties. Length, as surveyed, 151.3 miles; under construction, 93.7 miles.

ROUTE 8, from a connection with Route 1 near Ignacio to a connection with Route 7 either at Benicia or Cordelia, via Napa, through Marin, Sonoma and Napa counties. Length, as surveyed, 26.2 miles; under construction, 4.5 miles.

ROUTE 9, connecting San Bernardino with the main highway system, through Los Angeles and San Bernardino counties. Length, as surveyed, 31.8 miles; completed or under construction, 17.9 miles.

ROUTE 10, connecting Hanford with the main route and running to Visalia. Length, as surveyed, 18.5 miles.

ROUTE 11, connecting Placerville with the main route at Sacramento. Length, as surveyed, 29.1 miles; completed or under construction, 18.7 miles.

ROUTE 12, connecting El Centro with the main system at San Diego and running through Imperial and San Diego counties. Length, as far as surveys are completed, 102.5 miles; under construction, 21.4 miles.

ROUTE 13, connecting Sonora with the main system in the San Joaquin Valley through Stanislaus and Tuolumne counties. Length, as surveyed, 49.5 miles; under construction, 10.9 miles.

ROUTE 14, in Contra Costa County. Length, as surveyed, 20.8 miles; under construction, 10.6 miles.

ROUTE 15, connecting Colusa with Route 7 at Williams. Length, 8.5 miles.

ROUTE 16, connecting Lakeport with Route 1 at Hopland. Reconnaissance made.

ROUTE 17, connecting Auburn with the main road in the Sacramento Valley. Length, as surveyed, 15.6 miles.

ROUTE 18, connecting Mariposa with the main system in the San Joaquin Valley at Merced. Surveys in progress. Approximate length, 33.9 miles.

ROUTE 19, connecting Riverside with the main system at Los Angeles. Length, as surveyed, 16.9 miles; completed or under construction, 16.3 miles.

ROUTE 20, connecting Weaverville with the main system at Redding. Length, as surveyed, 47.9 miles.

ROUTE 21, from Richvale to Oroville, in Butte County. Length, as surveyed, 8.7 miles.

Progress of Construction

The following progress record gives the situation in each county of California as indicated, the percentage of work completed, mileage of the sections, status of surveys or other completed work, and awards and progress of construction:

Routes under way are located in the counties as follows, the figures in parentheses indicating the divisions: Alameda (Division IV), route 5; Alpine (III), Amador (III), Butte (III), 3 and 21; Calaveras (III), Colusa (III), 7 and 15; Contra Costa (IV), 14; Del Norte (I), 1; El Dorado (III), 11; Fresno (VI), 4, Glenn (III), 7; Humboldt (I), 1; Imperial (VII), 12; Inyo (VI), Kern (VI), 4, Kings (VI), 10; Lake (I), 16; Lassen (II); Los Angeles (VII), 2, 4 and 9; Madera (VI), 4; Marin (IV), 1; Mariposa (VI), 18; Mendocino (I), 1 and 16; Merced (VI), 4 and 18; Modoc (I); Mono (VI); Monterey (V), 2; Napa (IV), Nevada (III), 17; Orange (VII), 2; Placer (III), 3 and 17; Plumas (III); Riverside (VII), 19; Sacramento (III), 3, 4 and 11; San Benito (VI), 2; San Bernardino (VII), 9 and 19; San Diego (VII), 2 and 12; San Francisco (IV), touched by 2 and within ferry reach of 1, 5, 7 and 14; San Joaquin (III), 4 and 5; San Luis Obispo (V), 2; San Mateo (IV), 2; Santa Barbara (V), 2; Santa Clara (IV), 2 and 5; Santa Cruz (IV), 5; Shasta (II), 3 and 20; Sierra (III); Siskiyou (II), 3; Solano (III), 7, Sonoma (IV), 1; Stanislaus (III), 4 and 13; Sutter (III), 3, Tehama (II), 3 and 7; Trinity (II), 20; Tulare (VI), 4 and 10; Tuolumne (III), 13; Ventura (VII), 2; Yolo (III), 6 and 7; Yuba (III), 3.

ALAMEDA COUNTY.

Division IV. Route 5.

SECTION A, from the east boundary of the county to Livermore (IV—Ala.—5—A); length, 14.6 miles.

A_1, laid out as State Highway July 7, 1914. Contract (No. 90) awarded Aug. 11, 1914, to Parrott Bros. Co. Length, 5 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $42,525; per mile, $8,548. Amount of contract completed to Dec. 12, 1914, 40.4 per cent.

A_2, laid out as State Highway Aug. 26, 1914. Contract (No. 108) awarded Oct. 6, 1914, to Palmer & McBryde. Length 5.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $65,190; per mile, $11,090. Amount of contract completed to Dec. 12, 1914, 25.2 per cent. Surveys completed, and plans in progress for remainder of the section.

SECTION B, from Livermore to Hayward (IV—Ala.—5—B): Surveys completed. Plans in progress. Length 17.7 miles.

SECTION C, from Hayward to south boundary of the county (IV—Ala.—C): Surveys completed. Length 17.5 miles.

C_1, from Hayward to Valle Vista school, laid out as State Highway March 25, 1914. Contract (No. 61) awarded April 22, 1914, to Treslau Brothers. Length, 3.1 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $38,503; per mile, $12,340. Amount of contract completed to Nov. 15, 1914, 96.2 per cent.

C_2, laid out as State Highway March 25, 1914. Length, 4.4 miles. Pavement, oiled concrete 18 feet wide. Now being constructed by the state by day labor (No. D7).

C_3, laid out as State Highway Dec. 8, 1914. Length, 1.83 miles. Pavement, oiled concrete 18 feet wide. To be constructed by the state by day labor (No. D7). Plans and estimates for the remainder of the section are in progress.

SECTION D, from Oakland to Hayward (IV—Ala.—5—D): Laid out as State Highway March 25, 1914. Contract (No. 62) awarded April 22, 1914, to Ransome-Crummey Co. Length, 5.1 miles. Pavement, asphalt on concrete and macadam, 24 feet wide. Probable total cost, $56,955; per mile, $11,256. Work completed.

ALPINE COUNTY.

The Highway Commissioners have made a personal study of the possible routes to connect Markleeville with the trunk line, and on Sept. 24, 1914 directed the Highway Engineer to order such reconnaissances to be made as are necessary in advance of the construction surveys.

AMADOR COUNTY.

The Highway Commissioners have made a personal study of the possible routes to connect Jackson with the trunk line, and on Sept. 22, 1914, directed the Highway Engineer to order such reconnaissances to be made as are necessary in advance of the construction surveys.

BUTTE COUNTY.

Division III. Route 3.

SECTION A, from the south county line to Biggs (III—But.—3—A): Surveys completed. Plans and estimates in progress. Length, 7.4 miles.

SECTION B, from Biggs to Nelson (III—But. 3-B): Surveys completed. Plans and estimates in progress. Length, 10.1 miles.

SECTION C, from Nelson to Chico (III—But.—3-C): Surveys, plans and estimates completed. Length, 12.5 miles.

SECTION D, from Chico to the north boundary (III—But.—3-D): Laid out as State Highway October 22, 1912. Bids received Nov. 18, 1912. Contract (No. 70) awarded June 9, 1914, to P. L. Burr. Length, 11.2 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $109,690; per mile, $9,740. Amount of contract completed on Nov. 28, 1914, 44 per cent.

Route 21.

SECTION A, from Richvale to Oroville (III—But.—21-A): Surveys completed. Length, 8.7 miles.

CALAVERAS COUNTY.

The Highway Commissioners have made a personal study of the possible routes connecting San Andreas with the trunk line, and on Sept. 22, 1914, voted to instruct the Highway Engineer to order such reconnoissances made as are necessary in advance of the construction surveys.

COLUSA COUNTY.

Division III, Route 7.

SECTION A, from the south boundary to Berlin (III—Col.—7-A): Laid out as State Highway May 27, 1914. Contract (No. 80) awarded June 23, 1914, to C. L. Schaad. Length, 10.8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $108,550; per mile, $10,030. Amount of contract completed to Dec. 12, 1914, 45.9 per cent.

SECTION B, from Berlin to Colusa Junction (III—Col.—7-B): Laid out as State Highway July 21, 1914. Contract (No. 99) awarded Sept. 10, 1914, to C. L. Schaad. Length, 12.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $130,050; per mile, $10,320. Amount of contract completed to Dec. 12, 1914, 16.6 per cent.

SECTION C, from Colusa Junction to the north boundary (III—Col. 7-C): Surveys completed. Plans in progress. Length, 10.7 miles.

Route 15.

SECTION A, from Williams to Colusa (III—Col.—15-A): Laid out as State Highway Oct. 6, 1914. Length, 8.4 miles. Pavements, oiled concrete, 15 feet wide. Contract (No. 117) awarded Dec. 22, 1914, to C. W. Cross. Probable total cost, $97,190; per mile, $11,570.

CONTRA COSTA COUNTY.

Division IV, Route 14.

SECTION A, from the south boundary to Pinole (IV—C.C. 14-A): Length, 7.9 miles. Surveys completed.

A_1, laid out as State Highway July 7, 1914. Contract (No. 91) awarded Aug. 11, 1914, to James H. Falconer. Length, 3.6 miles. Road to be graded 21 feet wide. Probable total cost, $15,970; per mile, $4,450. Contract completed.

Plans in progress for remainder of the section.

SECTION B, from Pinole to Martinez (IV C.C. 14 B). Length, 12.9 miles.

B_1, laid out as State Highway Aug. 11, 1914. Contract (No. 103) awarded Sept. 22, 1914, to Bates, Borland & Ayer. Length, 7 miles. Road to be graded 21 feet wide. Probable total cost, $47,350; per mile, $6,770. Amount of contract completed to Nov. 15, 1914, 26.6 per cent.

Surveys, plans and estimates completed for remainder of the section.

DEL NORTE COUNTY.

Division I, Route 1.

SECTIONS A and B, from south boundary of Del Norte County to Crescent City (1—D.N.—1-A): Surveys ordered. Length, 31.7 miles.

EL DORADO COUNTY.

Division III, Route 11.

SECTION A, from the west boundary to Shingle Springs (III—E.D.—11-A): Surveys completed. Plans in progress. Length, 10.4 miles.

SECTION B, from Shingle Springs to El Dorado (III—E.D.—11-B): Laid out as State Highway May 21, 1913. Bids received and rejected June 30, 1913. Now being constructed by the state with day labor (No. D2). Length, 5.3 miles. Pavement, waterbound macadam, 12 feet wide. Probable total cost, $25,610; per mile, $4,860. Work is 95 per cent completed.

SECTION C, from El Dorado to Placerville (III—E.D.—11-C): Laid out as State Highway, Jan. 21, 1914. Bids received and rejected March 30, 1914. Now being constructed by the state with day labor (No. D5). Length, 6.6 miles. Pavement, oiled concrete 12 feet wide. Probable total cost, $61,220; per mile, $9,320. Work is 96.4 per cent completed.

FRESNO COUNTY.

Division VI, Route 4.

SECTION A, from the south boundary to Fowler (VI—Fre.—4-A): Laid out as State Highway Oct. 29, 1913. Contract (No. 48) awarded Nov. 21, 1913, to A. Teichert & Son. Length, 8.2 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $64,950; per mile, $7,915. Amount of contract completed to Dec. 12, 1914, 93.3 per cent.

SECTION B, from Fowler to Fresno (VI—Fre.—4-B): Laid out as State Highway Oct. 29, 1913. Contract (No. 47) awarded Nov. 21, 1913, to A. Teichert & Son. Length, 8.0 miles. Pavement, oiled concrete. 20 feet wide. Probable total cost, $67,335; per mile, $8,420. Contract completed.

SECTION C, from Fresno to Fresno-Madera county line (VI—Fre.—4-C): Laid out as State Highway July 23, 1912. Contract (No. 8) awarded Aug. 27, 1912, to the Worswick Street Paving Co. Length, 9.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $67,546; per mile, $7,065. Contract completed.

GLENN COUNTY.

Division III, Route 7.

SECTION A, from the south boundary line to Willows (III—Gle.—7-A): Laid out as State Highway Aug. 11, 1914. Contract (No. 113) awarded Nov. 24, 1914, to C. W. Cross. Length, 8.6 miles. Pavement, oiled concrete 15 feet wide.

SECTION B, from Willows to Grapit (III—Gle.—7-B): Surveys completed. Plans in progress. Length, 10.0 miles.

SECTION C, from Grapit to the north boundary line (III—Gle.—7-C): Laid out as State Highway April 22, 1914. Contract (No. 77) awarded June 9, 1914, to P. H. Hoare. Length, 6.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $60,550; per mile, $8,640. Amount of contract completed to Nov. 28, 1914, 98.8 per cent.

HUMBOLDT COUNTY.

Division I, Route 1.

SECTION A, from the south boundary to Garberville (I—Hum.—1-A): Survey completed. Length, 10.3 miles.

A_1, laid out as State Highway, Sept. 24, 1913. Contract (No. 44) awarded Oct. 29, 1913, to Fairbanks & Baechtel. Length, 5.5 miles. Road to be graded 18 feet wide. Probable total cost, $56,360; per mile, $10,270. Contract completed.

A_2, laid out as State Highway March 25, 1914. Contract (No. 60) awarded April 22, 1914, to Berry, Mackie & Co. Length, 4.6 miles. Road to be graded 18 feet wide. Probable total cost, $52,535; per mile, $11,470. Contract completed.

SECTION B, from Garberville to Miranda (I—Hum.—1-B): Surveys, plans and estimates completed. Length, 15.7 miles.

SECTION C, from Miranda to Dyerville (I—Hum.—1-C): Laid out as State Highway July 7, 1914. Contract (No. 93) awarded Aug. 11, 1914, to Fairbanks & Baechtel. Length, 13.8 miles. Road to be graded 18 feet wide. Probable total cost, $163,860; per mile, $11,900. Amount of contract completed to Dec. 12, 1914, 15.8 per cent.

SECTION D, from Dyerville to opposite Elinor (I—Hum.—1-D): Length, 11.3 miles.

D_1, laid out as State Highway May 27, 1914. Contract (No. 71) awarded June 9, 1914, to Smith & Connors. Length, 7.5 miles. Road to be graded 18 feet wide. Probable total cost, $87,850; per mile, $11,730. Work practically completed.

D_2, laid out as State Highway July 7, 1914. Contract (No. 104) awarded Oct. 6, 1914, to William Crowley and T. E. Cloney. Length, 3.7 miles. Road to be graded 18 feet wide. Probable total cost, $38,880; per mile, $10,500. Amount of contract completed to Dec. 12, 1914, 8.6 per cent.

SECTION E, from opposite Elinor to Rio Dell (1—Hum.—1-F): Surveys completed. Plans in progress. Length, 10 miles.

SECTION F, from Rio Dell to Fortuna (I—Hum. 1 F): Surveys completed. Plans in progress. Length, 8 miles.

SECTION G, from Fortuna to Eureka (I—Hum.—1-G): Length, 18 miles.

G_1, laid out as State Highway Aug. 26, 1914. Contract (No. 105) awarded Oct. 6, 1914, to Elsemore & Jacobs. Length, 4.3 miles. Road to be graded 24 feet wide. Probable total cost, $21,825; per mile, $5,075. Amount of contract completed to Dec. 12, 1914, 34.4 per cent.

Surveys completed and plans in progress for remainder of the section.

SECTION H, from Eureka to Arcata (I—Hum.—1-A): Surveys completed. Length, 12 miles.

SECTION I, from Arcata to Trinidad. Surveys in progress. Length, 15.4 miles.

SECTION J, from Trinidad to Orick. Length, 23.5 miles. Surveys in progress.

SECTION K, from Orick to the county line. Length, 16 miles.

IMPERIAL COUNTY.

Division VII, Route 12.

SECTION A, from the foot of Myers Canyon to Coyote Wells (VII—Imp.—12-A): Laid out as State Highway July 7, 1914. Contract (No. 107) awarded Oct. 6, 1914, to J. W. Calback. Length, 6 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $96,110; per mile, $15,970. Amount of contract completed to Dec. 12, 1914, 10 per cent.

SECTION B, from Coyote Wells to Dixieland (VII—Imp.—12-B): Laid out as State Highway Oct. 6, 1914. Contract (No. 116) awarded Dec. 8, 1914, to Rice & Dutcher. Length, 11.7 miles. Probable total cost, $118,250; per mile, $10,070.

SECTION C, from Dixieland to El Centro (VII—Imp.—12-C): Surveys completed. Plans in progress. Length 12.3 miles.

SECTION D, from the west county line of Imperial County to the foot of Myers Canyon (VII—Imp.—12-D): Surveys ordered. Approximate length 5.5 miles.

INYO COUNTY.

The Highway Commissioners have made a personal study of the possible routes connecting Independence with the trunk line and on Sept. 22, 1914, voted to instruct the Highway Engineer to order such reconnoissances to be made as are necessary in advance of the construction surveys.

KERN COUNTY.

Division VI, Route 4.

SECTION A, from the south boundary to Grapevine Creek (VI—Ker.—4-A): Laid out as State Highway July 21, 1914. Contract (No. 106) awarded Oct. 6, 1914, to A. C. McLean Construction Company. Length, 10.7 miles. Road to be graded 21 feet wide. Probable total cost, $74,050; per mile, $6,940. Amount of contract completed to Dec. 12, 1914, 5.4 per cent.

SECTION B, from Grapevine Creek to Sections 5 and 6, T. 32 S., R. 28 E., M. D. B. and M. (VI—Ker.—4-B): Laid out as State Highway June 23, 1914. Contract (No. 96) awarded Aug. 26, 1914, to Lynn S. Atkinson. Length, 17.3 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $242,595; per mile, $14,030. Amount of contract completed to Dec. 12, 1914, 11.1 per cent.

SECTION C, from Sections 5 and 6, T. 32 S., R. 28 E., M. D. B. and M. to Bakersfield (VI—Ker.—4-C): Laid out as State Highway May 27, 1914. Contract (No. 67) awarded May 27, 1914, to John D. Marsh. Length, 13.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $139,840; per mile, $10,770. Amount of contract completed to Dec. 12, 1914, 30.6 per cent.

SECTION D, from Bakersfield to Lerdo (VI—Ker 4-D): Laid out as State Highway Jan. 21, 1914. Contract (No. 50) awarded Feb. 26, 1914, to Geo. S. Benson & Sons. Length, 10.1 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $71,210; per mile, $7,025. Contract completed.

SECTION E, from Lerdo to Famosa (VI—Ker.—4-E): Laid out as State Highway Jan. 21, 1914. Contract (No. 51) awarded Feb. 26, 1914, to Geo. S. Benson & Sons. Length 8.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $56,720; per mile, $6,340. Amount of contract completed to Dec. 12, 1914, 42 per cent.

SECTION F, from Famosa to the north boundary of Kern County (VI—Ker.—4-F): Laid out as State Highway March 12, 1914. Contract (No. 63) awarded April 22, 1914, to Lynn S. Atkinson. Length, 12.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $108,340; per mile, $8,710. Amount of contract completed to Dec. 12, 1914, 98 per cent.

KINGS COUNTY.

Division VI, Route 10.

SECTION A, between Hanford and the east boundary of Kings County (VI Kin. 10-A). Surveys, plans and estimates complete. Length, 9.8 miles.

LAKE COUNTY.

Division 1, Route 16.

SECTION A from the west boundary of Lake County to Lakeport (I Lak. 16-A); Reconnoissance made.

LASSEN COUNTY.

The Highway Commissioners have made personal studies of the various routes to be considered in connecting Susanville with the trunk line, and on Sept. 22, 1914, voted to direct the Highway Engineer to order such reconnoissances made by the Division Engineer of Division II as may be necessary in advance of the construction surveys.

LOS ANGELES COUNTY.

Division VII, Route 2.

SECTION A, from County Highway No. 3 to Rancho El Encino (VII L. A. 2-A): Laid out as State Highway Sept. 25, 1912. Contract (No. 17) awarded Oct. 22, 1912, to Rogers Brothers Co. Length, 6.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $55,127; per mile, $8,353. Contract completed.

SECTION B, from Rancho El Encino to Calabasas (VII L. A. 2-B): Laid out as State Highway Feb. 4, 1913. Contract (No. 21) awarded March 4, 1913 to John D. Marsh. Length, 10.1 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $81,690, per mile, $8,063. Contract completed.

SECTION C, from Calabasas to the Los Angeles-Ventura county line (VII L. A. 2-C). Laid out as State Highway April 18, 1913. Contract (No. 35) awarded May 21, 1913, to Gillette, Montgomery & Tracy. Length, 11.3 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $133,290, per mile, $11,820. Work practically completed.

Remainder in Los Angeles County outside Los Angeles is county highway.

Route 4.

SECTION A, from Saugus to Castaic schoolhouse (VII L. A. 4-A): Surveys completed. Plans in progress. Length, 8.8 miles.

SECTION B, from Castaic schoolhouse to top of the ridge (VII L. A. 4-B) Laid out as State Highway Aug. 11, 1914. Contract (No. 101) awarded Sept. 22, 1914, to Mahoney Brothers. Length, 12.8 miles. Road to be graded 21 feet wide. Probable total cost, $134,860; per mile, $10,500. Amount of contract completed to Dec. 12, 1914, 13.6 per cent.

SECTION C, from top of the ridge to Liebre Mountain (VII-L. A. 4-C): Laid out as State Highway Nov. 24, 1914. Contract (No. 120) awarded Dec. 22, 1914, to Lee Moor Contracting Co. Length, 14.5 miles. Road to be graded 21 feet wide. Probable total cost, $303,572.46; per mile, $20,900.

SECTION D, from Liebre Mountain to the Los Angeles-Kern County line (VII L. A.-4-D): Laid out as State Highway May 27, 1914. Contract (No. 78) awarded June 9, 1914, to Lee Moor. Length, 12.6 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $201,140; per mile, $15,940. Amount of contract completed to Dec. 12, 1914, 45.9 per cent.

Route 9.

SECTION A, from San Fernando road to La Canada (VII-L. A. 9-A). Surveys completed. Plans in progress. Length 13.9 miles.

SECTION B, from La Canada to Pasadena (VII L. A.-9-B): Surveys in progress.

Route 19.

The portion of this route between Los Angeles and Riverside which is in Los Angeles County was constructed by that county and is still county highway.

MADERA COUNTY.

Division VI, Route 4.

SECTION A, from the south boundary of Madera County to the city of Madera (VI—Mad.—4-A): Laid out as State Highway July 23, 1912. Contract (No. 9) awarded Aug. 27, 1912, to the Worswick Street Paving Co. Length, 9.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $64,405; per mile, $6,473. Contract completed.

SECTION B, from Madera to Califa (VI-Mad.—4-B): Laid out as a State Highway May 21, 1912. Contract (No. 3) awarded July 23, 1912, to the Ransome Crummey Co. Length, 9.9 miles. Pavement, oiled macadam, 15 feet wide. Probable total cost, $68,890; per mile, $6,952. Contract completed.

SECTION C, from Califa to the north boundary of Madera County (VI Mad. 4-C): Laid out as State Highway July 23, 1912. Contract (No. 10) awarded Aug. 27, 1912, to the Worswick Street Paving Co. Length 6.8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $46,100; per mile, $6,750. Contract completed.

MARIN COUNTY.

Division IV, Route 1.

SECTION A, from the north boundary of Marin County to the west boundary of San Rafael (IV—Mrn. 1-A): Surveys completed. Plans and estimates in progress. Length, 16.8 miles.

SECTION B, from the west boundary of San Rafael to the ferry slip at Sausalito (IV Mrn.—1-B): Length, 7.2 miles.

B1, laid out as State Highway May 27, 1914. Contract (No. 65) awarded May 27, 1914, to O'Brien Brothers. Length, 6 miles. Road to be graded and part surfaced with gravel. Probable total cost, $66,380, per mile, $11,060. Contract completed.

Route 8.

SECTION A, from a junction with Route 1 three-fourths mile north of Ignacio to the east boundary of the county (IV Mrn. 8-A): Surveys completed. Plans in progress. Length, 3.7 miles.

MARIPOSA COUNTY.

Division VI, Route 18.

SECTION A, from the southwesterly county boundary to a point one mile south east of Cathay postoffice (VI Mar. 18-A). Length, 9.5 miles. Surveys in progress.

SECTION B, from a point one mile southeast of Cathay postoffice to Mariposa (VI—Mar.—18-B): Preliminary survey completed. Approximate length, 9.5 miles.

MENDOCINO COUNTY.

Division 1, Route 1.

SECTION A, from the south boundary of Mendocino County to Hopland (I Men. 1-A). Laid out as State Highway May 21, 1912. Contract (No. 2) awarded July 23, 1912, to the General Contracting Corporation. Length, 13.2 miles. Road graded 18 feet wide, but not paved. Probable total cost, $69,448; per mile, $5,314. Contract completed.

SECTION B, from Hopland to Ukiah (I Men. 1-B): Laid out as State Highway July 7, 1914. Contract (No. 87) awarded Aug. 11, 1914, to Hall Bros. Length, 12.5 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $107,490; per mile, $9,430. Amount of contract completed to Dec. 12, 1914, 16.8 per cent.

SECTION C, from Ukiah to Forsythe Creek (I Men. 1-C): Laid out as State Highway Feb. 4, 1913. Contract (No. 34) awarded March 26, 1913, to D. L. Sawyers and Chas. Whited. Length, 7.6 miles. Road to be waterbound macadam and gravel, 15 feet wide. Probable total cost, $55,650; per mile, $7,290. Contract completed.

SECTION D, from Forsythe Creek to Ridgewood (I Men. 1-D): Surveys completed. Length, 7.9 miles.

D1, laid out as State Highway Sept. 24, 1913. Length, 7.8 miles. Road to be graded 18 feet wide, but not paved. No. D4, 1.25 miles of this layout, graded by the state by day labor; work completed. Probable total cost, $8,800; per mile, $7,100.

D2, laid out as State Highway Sept. 24, 1913. Contract (No. 57) awarded April 22, 1914, to Hard Brothers. Length, 6.6 miles. Road to be graded 18 feet wide. Probable total cost, $57,800; per mile, $8,825. Amount of contract completed to Dec. 12, 1914, 97.2 per cent.

SECTION E, from Ridgewood to Willits (I Men. 1-E): Laid out as State Highway Oct. 22, 1912. Contract (No. 20) awarded Feb. 4, 1913, to Fairbanks & Baechtel. Length, 6.9 miles. Road graded 18 feet wide. Probable total cost, $38,855; per mile, $5,630. Contract completed.

SECTION F, from Willits to Arnold (I Men. 1-F): Surveys and plans completed. Length, 8.5 miles.

SECTION G, from Arnold to Sherwood-Laytonville Junction (I Men. 1-G): Surveys and plans completed. Length, 10.4 miles.

SECTION H, from Sherwood-Laytonville Junction to Rattlesnake Summit (I—Men. 1-H): Surveys and plans completed. Length, 14.2 miles.

SECTION I, from Rattlesnake Summit to Little Dan Valley (I- Men. 1-I): Surveys and plans completed. Length 13.6 miles.

SECTION J, from Little Dan Valley to Low Gap (I Men. 1-J): Surveys completed. Plans in progress. Length, 10.5 miles.

SECTION K, from Low Gap, to the north boundary of Mendocino County (I Men.—1-K): Surveys completed. Length, 13 miles.

Route 16.

SECTION A, from Hopland to east boundary of Mendocino County (I- Men. 16-A). Reconnoissance made.

MERCED COUNTY.

Division VI, Route 4.

SECTION A, from the south boundary to the City of Merced (VI—Mer.—4-A): Laid out as State Highway Oct. 22, 1912. Contract (No. 69) awarded May 27, 1914, to Taylor & Berliner. Length, 14.2 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $115,040; per mile, $8,110. Amount of contract completed to Dec. 12, 1914, 65.1 per cent.

Section B has been combined with Section A.

SECTION C, from Arena to Merced (VI Mer. 4-C): Laid out as State Highway Aug. 27, 1912. Contract (No. 11) awarded Sept. 29, 1912, to the Worswick Street Paving Co. Length, 10.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $84,710; per mile, $7,800. Contract completed.

SECTION D, from the north boundary of Merced County to Arena (VI Mer. 4-D): Laid out as State Highway July 23, 1912. Contract (No. 6) awarded Aug. 27, 1912, to the Worswick Street Paving Company. Length, 9.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $74,780; per mile, $7,780. Contract completed.

Route 18.

SECTION A, from the city limits of Merced to the easterly county line (VI - Mer. 18-A): Surveys completed. Plans in progress. Length, 14.9 miles.

MODOC COUNTY.

The Highway Commissioners have made personal studies of the possible routes to connect Alturas with the trunk line, and on Sept. 22, 1914, voted to instruct the Highway Engineer to order such reconnoissances to be made as are necessary in advance of the construction surveys.

MONO COUNTY.

The Highway Commissioners have made personal studies of the possible routes to connect Bridgeport with the trunk line, and on Sept. 22, 1914, voted to instruct the Highway Engineer to order such reconnoissances to be made as are necessary in advance of the construction surveys.

MONTEREY COUNTY.

Division V, Route 2.

SECTION A, from the northeast boundary of Monterey County to Salinas (V Mon. 2-A). Length, 10.45 miles.

A1, laid out as State Highway Aug. 27, 1913. Contract (No. 41) awarded Oct. 29, 1913, to E. O. Burge. Length, 4.3 miles. Road to be graded 21 feet wide, not paved. Probable total cost, $30,858, per mile, $7,103. Contract completed.

Surveys, plans and estimates have been completed for the remainder of the section.

SECTION B, from Salinas to a point 1,800 feet south of Chualar (V Mon. 2-B). Surveys, plans and estimates complete. Length, 10.3 miles.

SECTION C, from a point 1,800 feet south of Chualar to Camphora (V Mon. 2-C): Surveys complete. Plans in progress. Length, 11.0 miles.

SECTION D, from Camphora to Greenfield (V Mon. 2-D): Surveys completed. Plans in progress. Length, 12.2 miles.

SECTION E, from Greenfield to a point four miles north of King City (V Mon. 2-E): Laid out as State Highway Oct. 22, 1912. Length, 7.3 miles. Pavement, oiled concrete, 15 feet wide.

SECTION F, from a point 4 miles north of King City to San Lucas (V Mon. 2-F): Surveys completed. Length, 12.7 miles.

SECTION G, from San Lucas to San Ardo (V Mon. 2-G): Surveys completed. Plans in progress. Length, 10.8 miles.

SECTION H, from San Ardo to a point 11½ miles north of Bradley (V—Mon.—2-H): Surveys, plans and estimates complete. Length, 11.0 miles.

SECTION I, from a point 11½ miles north of Bradley to the south boundary line of Monterey County (V—Mon.—2-I): Surveys completed. Plans in progress. Length, 10.4 miles.

NAPA COUNTY.

Division IV, Route 8.

SECTION A, from the western boundary of the county to Napa (IV—Nap.—8-A): Surveys and plans completed. Length, 6.5 miles.

A_1, laid out as State Highway Sept. 22, 1914. Length, 4.5 miles. Pavement, oiled concrete 15 feet wide. Now being constructed by the state by day labor (No. D15). Amount of contract completed to Dec. 12, 1914, 57.4 per cent.

Plans and estimates for remainder of the section are in progress.

SECTION B, from Napa to the county line. Reconnaissance ordered.

NEVADA COUNTY.

The Highway Commissioners have made personal studies of the possible routes for connecting Nevada City via Grass Valley with the trunk line, and have directed the Highway Engineer to order the reconnaissances necessary in advance of the construction surveys. Such reconnoissances have been made on two of the possible routes.

ORANGE COUNTY.

Division VII, Route 2.

SECTION A, from the southern boundary to Galivan (VII—Ora.—2-A): Surveys completed. Length, 15.4 miles.

A_1, laid out as State Highway Oct. 6, 1914. Now being constructed by the state by day labor (No. D19). Length, 3.6 miles. Road to be graded 21 feet wide.

A_2, laid out as State Highway Oct. 6, 1914. Contract (No. 119) awarded Dec. 22, 1914, to the M. R. Construction Co., Inc. Length, 5.5 miles. Probable total cost, $53,710; per mile, $9,710.

SECTION B, from Galivan to Irvine (VII—Ora.—2-B): Laid out as State Highway July 7, 1914. Contract (No. 97) awarded Aug. 26, 1914, to B. R. Davisson Contracting Co. Length, 9.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $94,350; per mile, $10,070. Amount of contract completed to Nov. 15, 1914, 8.1 per cent.

SECTION C, from Irvine to Santa Ana (VII—Ora.—2-C): Laid out as State Highway July 21, 1914. Contract (No. 98) awarded September 10, 1914, to White & Gaskill. Length, 7.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $54,850; per mile, $7,410. Amount of contract completed to Dec. 12, 1914, 8.9 per cent.

SECTION D, from Santa Ana to Anaheim (VII—Ora.—2-D): See Section F, following.

SECTION E, from Anaheim to Fullerton (VII—Ora.—2-E): See Section F, following.

SECTION F, from Fullerton to the Los Angeles County boundary (VII—Ora.—2-F): With Sections D and E, laid out as State Highway August 27, 1913. Contract (No. 40) awarded Oct. 29, 1913, to Conner Contracting Co. Length, 11.2 miles. Pavement, Sections D and E, asphalt on concrete; Section F, oiled concrete, 18 feet wide. Probable total cost, $86,900; per mile, $7,790. Work completed. Surfacing under separate contracts (Nos. D12, D20 and D23); work completed on Sections D and E.

PLACER COUNTY.

Division III, Route 3.

SECTION A, from the south boundary line to Lincoln (III—Pla. 3-A): Laid out as State Highway Aug. 27, 1912. Contract (No. 13) awarded September 25, 1912, to Burns, Clark & De Roza. Length, 9.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $83,600; per mile, $8,430. Contract completed.

SECTION B, from Lincoln to the Placer-Yuba County line (III—Pla.—3-B): Surveys completed. Plans and estimates in progress. Length, 9.4 miles.

Route 17.

SECTION A, from Roseville to Penryn (III—Pla.—17-A): Surveys completed. Length, 9.1 miles.

SECTION B, from Penryn to Auburn (III—Pla.—17-B): Surveys completed. Length, 6.5 miles.

PLUMAS COUNTY.

The Highway Commissioners have made personal studies of possible routes connecting Quincy with the trunk line, and on Sept. 22, 1914, voted instructions to the Highway Engineer to order such reconnoissances as are necessary in advance of the construction surveys.

RIVERSIDE COUNTY.

Division VII, Route 19.

SECTION A, from the Riverside-San Bernardino County line to Riverside (VII—Riv.—19-A): Laid out as State Highway Sept. 24, 1913. Contract (No. 43) awarded Oct. 29, 1913, to the M. R. Company, Inc. Length, 10.3 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $59,175; per mile, $6,340. Contract completed.

SACRAMENTO COUNTY.

Division III, Route 3.

SECTION A, from the Auburn road to the north boundary line of Sacramento County (III—Sac. 3-A): Laid out as State Highway Aug. 27, 1912. Contract (No. 12) awarded Sept. 25, 1912, to Burns, Clark & De Roza. Length, 1.8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost $15,057; per mile, $8,183. Contract completed.

Route 4.

The portion of Route 4 in Sacramento County was constructed by the county and is still county highway.

Route 11.

SECTION A, from Folsom to the east boundary of the county (III—Sac.—11-A): Laid out as State Highway Aug. 11, 1914. Contract (No. 112) awarded Nov. 10, 1914, to A. W. and C. H. Gorrill. Length, 6.8 miles. Pavement, oiled concrete, 12 feet wide. Probable total cost, $65,065; per mile, $9,560.

SAN BENITO COUNTY.

Division V, Route 2.

SECTION A, from the north boundary to the southwest boundary of the county through San Juan Bautista (V—S. Bt.—2-A): Survey and plans completed. Length, 9.2 miles.

A_1, laid out as State Highway Aug. 27, 1913. Contract (No. 42) awarded Oct. 29, 1913, to E. O. Burge. Length, 4.2 miles. Road graded 21 feet wide, not paved. Probable total cost, $27,650; per mile, $6,550. Contract completed.

A_2, laid out as State Highway Aug. 27, 1913. Length, 4 miles. Pavement oiled concrete, 15 feet wide. Bids received July 6, 1914, and rejected. Readvertised, and bids received Aug. 24, 1914, and rejected. Now being constructed by the state by day labor (No. D8). Amount completed to Dec. 12, 1914, 30.5 per cent.

SAN BERNARDINO COUNTY.

Division VII, Route 9.

SECTION A, from Upland to Citrus Avenue (VII—S. Bd.—9-A): Laid out as State Highway Oct. 29, 1913. Contract (No. 46) awarded Nov. 21, 1913, to Hudson-Johnson Construction Co. Length, 10.4 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $77,270; per mile, $7,460. Work practically completed.

SECTION B, from Citrus Ave. to Rialto (VII—S. Bd.—9-B): Survey completed. Length, 4 miles. See Section C.

SECTION C, from Rialto to San Bernardino (VII—S. Bd.—9-C): Survey completer. Length, 1.8 miles. Sections B and C laid out as State Highway July 23, 1913. Contract (No. 38) awarded Aug. 11, 1913, to C. J. Flower. Length, 5.8 miles. Pavement, oiled concrete 18 feet wide. Probable total cost, $45,925; per mile, $7,880. Work completed.

SECTION D, from the San Bernardino-Los Angeles County line to Upland (VII—S. Bd.—9-D): Laid out as State Highway Jan. 21, 1914. Contract (No. 53) awarded Feb. 26, 1914, to Louis Ferrell. Length, 1.7 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $17,375; per mile, $10,305. Contract completed.

Route 19.

SECTION A, from the San Bernardino-Los Angeles County line to Ontario (VII—S. Bd. 19-A): Survey completed. Length, 2 miles. See Section B.

SECTION B, from Ontario to the San Bernardino-Riverside County line (VII—S. Bd.—19-B): Survey completed. Length, 4.6 miles. Sections A and B laid out as State Highway June 25, 1913. Contract (No. 37) awarded as a whole July 23, 1913, to Bent & Pennebaker. Length, 6.6 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $52,840; per mile, $7,995. Contract completed.

SAN DIEGO COUNTY.

Division VII, Route 2.

SECTION A, from the north city limits of San Diego to C Street, Encinitas (VII—S. D. 2-A): Laid out as State Highway July 23, 1912. Contract (No. 7) awarded Aug. 27, 1912, to M. L. Curtis & Co. Length, 8.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $69,157; per mile, $8,213. Contract completed.

SECTION B, from C street, Encinitas, to the south city limits of Oceanside (VII—S. D.—2-B): Laid out as State Highway, Oct. 22, 1912. Contract (No. 30) awarded May 21, 1913, to J. M. Montgomery. Length, 10.5 miles. Pavement, oiled concrete. 15 feet wide. Probable total cost, $82,190; per mile, $7,870. Work completed.

SECTION C, from the north city limits of Oceanside to the Santa Fe crossing 1 mile north of Las Flores station (VII—S. D.—2-C): Laid out as State Highway July 23, 1913. Contract (No. 39) awarded Sept. 24, 1913, to the C. L. Hyde Construction Co. Length, 8 miles. Payment, oiled concrete, 15 feet wide, Probable total cost, $67,775; per mile, $8,440. Work completed.

SECTION D, from the Santa Fe crossing 1 mile north of Las Flores station to the San Diego-Orange County line (VII—S. D.—2-D): Laid out as State Highway Feb. 26, 1914. Contract (No. 58) awarded April 22, 1914, to W. A. Perry. Length, 11.6 miles. Pavement, oiled concrete. 15 feet wide. Probable total cost, $108,870; per mile, $9,395. Amount of contract completed to Dec. 12, 1914, 53.7 per cent.

Route 12.

SECTION A, from East San Diego to La Mesa (VII S. D.—12-A): Laid out as State Highway March 25, 1914. Contract (No. 59) awarded April 22, 1914, to C. L. Hyde Construction Co. Length, 2.0 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $18,590; per mile, $9,460. Contract completed.

SECTION B, from La Mesa to El Cajon (VII—S. D.—12-B): Laid out as State Highway June 23, 1914. Contract (No. 94) awarded Aug. 26, 1914, to C. L. Hyde Construction Co. Length, 1.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $17,625; per mile, $11,320. Amount of contract completed to Nov. 15, 1914, 94.6 per cent.

SECTION C, from El Cajon to Alpine (VII—S. D.—12-C): Surveys and plans completed. Length, 14.5 miles.

SECTION D, from Alpine to Pine Valley (VII—S. D.—12-D): Surveys completed. Plans in progress. Length, 16.7 miles.

SECTION E, from Pine Valley to Glencoe school (VII—S. D.—12-D): Surveys completed. Plans in progress. Length, 6.9 miles.

SECTION F, from Glencoe School to Tecate Divide (VII S. D. 12-F): Surveys completed. Length, 11 miles.

SECTION G, from Tecate Divide to the east boundary of San Diego County (VII—S. D.—12-G): Surveys in progress. Length, 17 miles.

SECTION H, from the east city limits of San Diego to the old east city limits of East San Diego (VII—S.D.—12-H): Surveys and plans completed. Length, 3.5 miles.

SAN FRANCISCO COUNTY.

San Francisco is adjacent to Routes 1, 2, 5, 7, 8 and 14, which converge toward that city.

SAN JOAQUIN COUNTY.

Division III, Routes 4 and 5.

These were constructed by the county and are still county highways.

SAN LUIS OBISPO COUNTY.

Division V, Route 2.

SECTION A, from the north boundary of San Luis Obispo County to Paso Robles (V—S. L. O.—2–A): Laid out as State Highway Oct. 29, 1913. Contract (No. 56) awarded Feb. 26, 1914, to W. A. Dontanville. Pavement, oiled concrete, 15 feet wide. Length, 10.6 miles. Probable total cost, $117,255; per mile, $11,060. Amount of contract completed to Dec. 12, 1914, $5.2 per cent.

SECTION B, from Paso Robles to a point where Atascadero Creek crosses the Highway west of Atascadero Station (V—S. L. O.—2–B): Laid out as State Highway July 21, 1914. Length, 10 miles. Pavement, oiled concrete 15 feet wide. Bids received Aug. 21, 1914, and rejected. Bids received Oct. 5, 1914. Award pending.

SECTION C, from a point where Atascadero Creek crosses the Highway west of Atascadero Station to Santa Margarita (V—S. L. O.—2–C): Laid out as State Highway Oct. 29, 1913. Contract (No. 55) awarded Feb. 26, 1914, to W. A. Dontanville. Pavement, oiled concrete, 15 feet wide. Length, 8.4 miles. Probable total cost, $81,630; per mile, $9,780. Work practically completed.

SECTION D, from Santa Margarita to San Luis Obispo (V—S. L. O.—2–D): Surveys, plans and estimates completed. Length, 10 miles.

D_1, laid out as State Highway Oct. 22, 1912. Bids received and rejected Nov 18, 1912. Bids received and rejected June 30, 1913. Work now under construction (No. D3) by the state, using day labor. Length, 6.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $63,970; per mile, $10,040. Work nearly completed.

D_2, laid out as State Highway Aug. 26, 1914. Contract (No. 110) awarded Oct. 20, 1914, to Enoch J. Hunt. Length, 3.6 miles. Road to be graded 15 feet wide. Total probable cost, $53,110; per mile, $14,710. Amount of contract completed to Dec. 12, 1914, 8.5 per cent.

SECTION E, from San Luis Obispo to Arroyo Grande, via Pismo (V—S. L. O.—2–E): Laid out as State Highway June 20, 1914. Contract (No. 84) awarded July 7, 1914, to Rogers Bros. Co. Length, 13.4 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $168,235; per mile, $12,540. Amount of contract completed to Dec. 12, 1914, 56.2 per cent.

SECTION F, from Arroyo Grande to the south boundary line of the county (V—S. L. O.—2–F): Surveys, plans and estimates completed. Length, 12.4 miles.

SAN MATEO COUNTY.

Division IV, Route 2.

SECTION A, from the north boundary of San Mateo County to San Mateo City (IV—S. M.—2–A): Length, 10.7 miles.

A_1, from South San Francisco to Burlingame: Laid out as State Highway May 21, 1912. Contract (No. 1) awarded July 23, 1912, to F. R. Ritchie & Co. Length, 5.4 miles. Sheet asphalt, 24 feet wide, on concrete base. Probable total cost, $93,004; per mile, $17,223. Contract completed.

A_2, from Burlingame to Hillsborough: Laid out as State Highway Oct. 22, 1912. Contract (No. 29) awarded April 23, 1913, to Clark & Henery Construction Co. Length, 0.2 mile. Road 24 feet wide. Asphaltic concrete on Portland cement concrete base. Probable cost, $5,637; per mile, $28,184. Contract completed.

A_3, from the north boundary line of the county to the south line of Daly City: Laid out as State Highway March 26, 1913. Contract (No. 26) awarded April 23, 1913, to Flynn & Treacy. Length, 1.02 miles. Road 24 feet wide. Asphaltic concrete on Portland cement concrete base. Probable total cost, $20,303; per mile, $19,866. Contract completed.

A_4, Cypress Lawn Cemetery to South San Francisco: Laid out as State Highway May 21, 1913. Contract (No. 34) awarded July 3, 1913, to Mahoney Brothers. Length, 2.1 miles. Road to be graded forty feet wide, for future pavement of 24 feet width. Probable total cost of grading, $27,847; per mile, $13,260. Contract completed.

A_5, south line of Daly City to South San Francisco: Laid out as State Highway Feb. 26, 1914. Contract (No. 54) awarded Feb. 26, 1914, to Bates, Borland & Ayer. Length, 4 miles. Road to be asphalt surface on concrete base, 24 feet wide. Probable total cost, $85,815; per mile, $21,220. Contract completed.

SECTION B, from San Mateo City to the south boundary of the county (IV—S. M.—2–B): Surveys and plans completed. Length, 9.4 miles.

B_1, Redwood City to south boundary of county: Laid out as State Highway Oct. 22, 1912. Contract (No. 22) awarded March 26, 1913, to S. P. Doyle. Length, 3.3 miles. Road to be asphaltic concrete on macadam base, 20 feet wide. Probable total cost, $50,990; per mile, $15,450. Contract completed.

B_2, San Mateo to Beresford: Laid out as State Highway March 26, 1913. Contract (No. 27) awarded April 23, 1913, to Raisch Improvement Co. Length, 1.8 miles. Road to be asphaltic concrete on macadam base, 20 feet wide. Probable total cost, $28,245; per mile, $15,690. Contract completed.

B_3, at San Francisquito Creek: Laid out as State Highway Jan. 21, 1914. Constructed by the state by day lahor (No. D9). Asphalt on macadam, 20 feet wide. Length, 0.2 mile. Work completed.

SANTA BARBARA COUNTY.

Division V, Route 2.

SECTION A, from the north boundary of the county to a point 1 mile north of Bicknell (V—S. B.—2–A): Length, 10.6 miles.

A_1, laid out as State Highway June 23, 1914. Contract (No. 93) awarded Aug. 26, 1914, to Arthur S. Bent Construction Co. Length, 6.5 miles. Pavement, asphalt on concrete, 15 feet wide. Probable total cost, $92,820; per mile, $14,330. Amount of contract completed to Dec. 12, 1914, 23.8 per cent.

A_2, laid out as State Highway July 21, 1914. Length, 3.6 miles. Pavement, oiled concrete, 15 feet wide. Bids received Aug. 31, 1914, and rejected. Bids received Oct. 5, 1914; award pending.

SECTION B, from a point 1 mile north of Bicknell to Los Alamos (V—S. B.—2–B): Laid out as State Highway May 21, 1913. Contract (No. 36) awarded July 3, 1913, to Mayer & Lewis. Length, 11.9 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $125,810; per mile, $10,585. Amount of contract completed to Dec. 12, 1914, 59 per cent.

SECTION C, from Los Alamos to Zaca Station (V—S. B.—2–C): Laid out as State Highway Aug. 26, 1914. Length, 8.7 miles. Pavement, oiled concrete, 15 feet wide. Bids received Oct. 5, 1914; award pending.

SECTION D, from Zaca Station to Gaviota Pass (V—S. B.—2–D): Surveys completed. Plans in progress. Length, 11.9 miles.

SECTION E, from Gaviota Pass to Alcatraz schoolhouse (V—S. B.—2–E): Surveys completed. Length, 8.3 miles.

E_1, laid out as State Highway Aug. 11, 1914. Contract (No. 115) awarded Dec. 8, 1914, to J. W. Calback. Length, 1.9 miles. Pavement, oiled concrete, 15 feet wide. Total probable cost, $94,220; per mile, $19,220.

Plans in progress on remainder of the section.

SECTION F, from Alcatraz schoolhouse to El Capitan crossing (V—S. B.—2–F): Laid out as State Highway July 7, 1914. Contract (No. 92) awarded Aug. 11, 1914, to T. K. Beard. Length, 9.3 miles. Road to be graded, 21 feet wide. Probable total cost, $94,220; per mile, $10,120. Amount of contract completed to Dec. 12, 1914, 25.8 per cent.

SECTION G, from El Capitan crossing to Stony Creek (V—S. B.—2–G): Surveys completed. Plans completed. Length, 9.4 miles. See Section I.

SECTION H, from Carpinteria to the south boundary of Santa Barbara County (V—S. B.—2–H): Laid out as State Highway Oct. 29, 1913. Contract (No. 45) awarded Nov 21, 1913, to Occidental Construction Co. Length, 2.4 miles. Grading, 15 feet wide. Probalde total cost, $17,340; per mile, $7,380. Contract completed.

SECTION I, from Stony Creek to Glen Anne Canyon road (V—S. B.—2–I): Surveys, plans and estimates completed. Length, 0.8 mile.

SECTIONS G and I laid out as State Highway July 21, 1914. Contract (No. 109) awarded Oct. 6, 1914, to C. H. Hudson. Length, 10.2 miles. Road to be graded 21 to 24 feet wide. Probable total cost, $89,815; per mile, $8,800. Amount of contract completed to Nov. 28, 1914, 8.2 per cent.

SECTION J, Serena Gap, from county road to Serena station (V—S. B.—2–J): Laid out as State Highway Dec. 8, 1914. Length, 0.69 mile. Road to be graded 21 feet wide. Constructed by the state by day labor (No. D16); completed.

SANTA CLARA COUNTY.

Division IV, Route 2.

SECTION A, from the north boundary of Santa Clara County to San Jose (IV—S. Cl.—2–A): Surveys and plans complete. Length, 15.1 miles.

A_1 Palo Alto to Stevens Creek bridge: Laid out as State Highway July 23, 1912. Contract (No. 14) awarded Oct. 22, 1912, to City Street Improvement Co. Length, 6.4 miles. Road to he asphaltic concrete on macadam base, 20 feet wide. Probable total cost, $43,275; per mile, $6,725. Work completed.

A_2, Stevens Creek bridge to Saratoga-Lawrence road: Laid out as State Highway July 23, 1912. Contract (No. 15) awarded Oct. 22, 1912, to A. Teichert & Son. Length, 5.5 miles. Pavement, oiled concrete, 20 feet wide. Probable total cost, $54,294; per mile, $9,854. Contract completed.

A_3, Saratoga-Lawrence road to Santa Clara: Laid out as State Highway April 23, 1913. Contract (No. 32) awarded May 21, 1913, to John Doyle. Length, 1.2 miles. Pavement, oiled concrete, 20 feet wide, with broken stone shoulders 5 feet wide. Probable total cost, $15,168; per mile, $13,190. Contract completed.

A_4, from Santa Clara to San Jose (The Alameda): Laid out as State Highway July 7, 1914 Contract (No. 88) awarded Aug. 11, 1914, to Ransome-Crummey Co. Length, 1.9 miles. Pavement, 2 sections, asphalt on concrete, each 12 feet wide with car line between the sections. Probable total cost, $41,970; per mile, $21,745. Amount of contract completed to Nov 15, 1914, 11.5 per cent.

A_5, at San Francisquito Creek: Laid out as State Highway Jan. 21, 1914. Constructed by the state by day labor (No. D10). Length, 0.08 mile. Pavement, bituminous concrete, 20 feet wide. Work completed.

SECTION B, from San Jose to Morgan Hill (IV—S. Cl.—2 B): Survey and plans completed. Length, 17.3 miles.

B_1, Edenvale to Morgan Hill: Laid out as State Highway Oct. 22, 1912. Contract (No. 23) awarded March 26, 1913, to Richard Keatinge & Sons. Length, 13 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $87,880; per mile, $6,785. Contract completed, but not fully paid.

B_2, San Jose to Edenvale: Laid out as State Highway March 26, 1913. Contract (No. 28) awarded April 23, 1913, to Richard Keatinge & Sons. Length, 4.3 miles. Pavement, oiled concrete, 15 to 20 feet wide. Probable total cost, $32,400; per mile, $7,450. Work completed, but not fully paid.

B_3, San Jose to Mulia: Laid out as State Highway March 26, 1913. Contract (No. 64) awarded April 22, 1914, to John W. McDonald, Jr. Length, 1.8 miles. Asphalt surfacing on portion of Contract No. 28. Probable total cost, $13,820; per mile, $7,510. Contract completed.

B_4, at Morgan Hill: Laid out as State Highway Sept. 22, 1914. To be constructed by the state by day labor (No. D21). Length, 0.4 mile Pavement, oiled concrete, 15 feet wide.

SECTION C, from Morgan Hill to the south boundary of the county (IV—S. Cl.—2–C): Survey complete. Length, 13.9 miles.

C_1, Morgan Hill to Gilroy: Laid out as State Highway May 21, 1913. Contract (No. 35) awarded July 3, 1913, to E. O. Burge. Length, 7.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $50,800; per mile, $6,690. Work practically completed.

C_2, Gilroy to Sargent: Laid out as State Highway May 27, 1914 Contract (No. 72) awarded June 9, 1914, to H. L. Peterson and V. J. Grier. Length, 6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $67,560; per mile, $11,260. Contract practically completed.

C_3, at Llagas Creek Laid out as State Highway Jan. 21, 1914. Being constructed by the state by day labor (No. D18). Length, 0.26 miles. Pavement, oiled concrete, 15 feet wide.

Route 5.

SECTION A, from the north boundary to San Jose (IV—S. Cl.—5–A): Laid out as State Highway July 7, 1914. Contract (No. 89) awarded Aug. 11, 1914, to John W. McDonald, Jr. Length, 6.8 miles. Pavement, oiled concrete, 18 feet wide. Probable total cost, $73,095; per mile, $10,770. Amount of contract completed to Dec. 12, 1914, 22.9 per cent.

SECTION B, from San Jose to the south boundary (IV—S. Cl.—5–B): Surveys completed. Length, 14.48 miles.

B_1, laid out as State Highway Aug. 11, 1914. Contract (No. 102) awarded Sept. 22, 1914, to John A. Marshall. Length, 7.6 miles. Road to be graded 20 feet wide Probable total cost, $79,960; per mile, $10,535 Amount of contract completed to Dec. 12, 1914, 1.9 per cent.

Plans and estimates in progress for the remainder of the section.

SANTA CRUZ COUNTY.

Division IV, Route 5.

SECTION A, from the north boundary of Santa Cruz County to the city of Santa Cruz (IV—S. Cr.—5–A): Survey complete. Length 16.0 miles.

A_1, from the north boundary of Santa Cruz County to Glenwood. Laid out as State Highway Jan. 21, 1914. Contract (No. 49) awarded Feb. 26, 1914, to

Martin S. Foss and John A. Marshall. Length, 5.7 miles. Road is to be graded 18 feet wide. Probable total cost, $62,365; per mile, $10,910. Work practically completed.

A_2, from Glenwood to Santa Cruz; laid out as State Highway June 23, 1914. Contract (No. 83) awarded July 7, 1914, to Occidental Construction Company. Length, 10.3 miles. Road to be graded 21 feet wide. Probable total cost, $62,500; per mile, $6,050. Amount of contract completed to Dec. 12, 1914, 63.9 per cent.

SHASTA COUNTY.

Division II, Route 3.

SECTION A, from the south boundary of the county to Redding (II—Sha.—3–A): Surveys completed. Plans and estimates in progress. Length, 15.88 miles.

SECTION B, from Redding to Baird (II—Sha.—3–B): Surveys completed. Plans and estimates completed. Length, 18.95 miles.

SECTION C, from Baird to La Moine (II—Sha.—3–C): Surveys completed. Plans and estimates completed. Length, 23.94 miles.

SECTIONS B and C laid out as State Highway June 23, 1914. Contract (No. 85) awarded July 21, 1914, to Palmer & McBryde. Length, 16.2 miles. Road to be graded 16 feet wide. Probable total cost, $185,000; per mile, $11,415. Amount of contract completed to Dec. 12, 1914, 36.9 per cent.

SECTION D, from La Moine to the north boundary of the county (II—Sha.—3–D): Surveys completed. Length, 21.4 miles.

D_1, from La Moine to Hazel Creek: Laid out as State Highway, April 22, 1914. Contract (No. 75) awarded June 9, 1914, to F. Rolandi. Length, 9.9 miles. Road to be graded 16 feet wide. Probable total cost, $71,370; per mile, $7,190. Amount of contract completed to Dec. 12, 1914, 74.5 per cent.

Plans and estimates on remaining portion of the section are partially complete.

Route 20.

SECTION A, from the west boundary of Shasta County to Stella (II—Sha.—20–A): Surveys in progress. Length, 14 miles.

SECTION B, from Stella to Redding (II—Sha.—20–B): Surveys in progress. Length, 12 miles.

SIERRA COUNTY.

The Highway Commissioners have made personal studies of the possible routes to connect Downieville with the other counties, and centers of population of the state, and on Sept. 22, 1914, voted to instruct the Highway Engineer to order such reconnoissances as may be necessary in advance of the construction surveys.

SISKIYOU COUNTY.

Division II, Route 3.

SECTION A, from the south boundary of the county to Weed (II—Sis.—3–A): Surveys completed. Length, 20.7 miles.

A_1, laid out as State Highway Aug. 11, 1914. Contract (No. 100) awarded Sept. 22, 1914, to Toohey & Johnson. Length, 16.6 miles. Road to be graded 18 feet wide. Probable total cost, $74,730; per mile, $4,500. Amount of contract completed to Nov. 15, 1914, 6.4 per cent.

Plans and estimates on the remainder of the section are completed.

SECTION B, from Weed to Yreka (II—Sis.—3–B): Surveys completed. Plans and estimates in progress. Length, 28.46 miles.

SECTION C, from Yreka to the California-Oregon boundary line. (II—Sis.—3–C): Surveys completed. Length, 26.36 miles.

C_1, from Hornbrook to the California-Oregon boundary line: Laid out as State Highway April 22, 1914. Contract (No. 66) awarded May 27, 1914, to W. H. Mason and F. T. Fradenburgh. Length, 8 miles. Road to be graded 18 feet wide. Probable total cost, $35,750; per mile, $4,450. Amount of contract completed to Nov. 28, 1914, 82.3 per cent.

C_2, laid out as State Highway Nov. 10, 1914. Contract (No. 118) awarded to E. T. Johnson Dec. 22, 1914. Length, 16.9 miles. Road to be graded 18 and 21 feet wide. Probable total cost, $108,470; per mile, $6,410.

SOLANO COUNTY.

Division III, Route 7.

SECTION A, from Benicia to a point 2½ miles south of Cordelia (III—Sol.—7–A): Laid out as State Highway March 25, 1914. Contract (No. 79) awarded June 9, 1914, to Commary-Peterson Co., Inc. Length, 9.1 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $102,940; per mile, $11,375. Amount of contract completed to Dec. 12, 1914, 25.3 per cent.

SECTION B, from a point 2½ miles south of Cordelia to Fairfield (III—Sol.—7–B): Laid out as State Highway Oct. 20, 1914. Contract (No. 114) awarded Nov. 24, 1914, to P. H. Hoare. Length, 8.1 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $77,630; per mile, $9,630.

SECTION C, from Fairfield to Vacaville (III—Sol.—7–C): Laid out as State Highway May 27, 1914. Contract (No. 74) awarded June 9, 1914, to Commary-Peterson Co., Inc. Length, 8.8 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $89,870; per mile, $10,215. Amount of contract completed to Nov. 28, 1914, 82.3 per cent.

SECTION D, from Vacaville to a point ¾ mile northeast of Batavia (III—Sol.—7–D): Laid out as State Highway Aug. 11, 1914. Contract (No. 111) awarded Nov. 10, 1914, to P. L. Burr. Length, 8.2 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $80,690; per mile, $9,875.

SECTION E, from a point ¾ mile northeast of Batavia to the north boundary of the county (III—Sol.—7 E): Surveys completed. Plans in progress. Length, 8.4 miles.

Route 8.

SECTION A, reconnoissance ordered.

SONOMA COUNTY.

Division IV, Route 1.

SECTION A, from the north boundary of the county to the south boundary of Healdsburg (IV—Son.—1–A): Length, 20.8 miles.

A_1, from the north boundary to Cloverdale: Laid out as State Highway April 22, 1914. Contract (No. 68) awarded May 27, 1914, to Hard Brothers. Length, 4.45 miles. Road to be graded 21 feet wide. Probable total cost, $43,355; per mile, $9,740. Amount of contract completed to Dec. 12, 1914, 70.2 per cent.

Surveys completed and plans in progress for the remainder of the section.

SECTION B, from the south boundary of Healdsburg to the north boundary of Santa Rosa (IV—Son.—1–B): Laid out as State Highway Sept. 25, 1912. Contract (No. 16) awarded Oct. 22, 1912, to Richard Keating & Sons. Length, 13.7 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $108,760; per mile, $7,940. Work completed.

SECTION C, from the south boundary of Santa Rosa to the south boundary of Sonoma County (IV—Son.—1–C): Surveys completed. Plans in progress. Length, 18.7 miles.

Route 8.

SECTION A, from Petaluma Creek to Sonoma Creek (IV—Son.—8–A): Length, 11.6 miles. Surveys in progress.

SECTION B, from Sonoma Creek to the Napa County line (IV—Son.—8–B): Length, 4.4 miles. Surveys completed. Plans in progress.

STANISLAUS COUNTY.

Division III, Route 4.

SECTION A, from the south boundary of Stanislaus County to a point 1½ miles north of Ceres (III—Sta.—4–A): Laid out as State Highway July 23, 1912. Contract (No. 5) awarded Aug. 27, 1912, to E. O. Burge. Length, 12 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $89,429; per mile, $7,428. Contract completed.

SECTION B, from a point 1½ miles north of Ceres to the north boundary of Stanislaus County (III—Sta.—4–B): Laid out as State Highway March 4, 1913. Contract (No. 25) awarded March 26, 1913, to Considine & Bates Co. Length, 9.6 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $67,795; per mile, $7,080. Contract completed.

Route 13.

SECTION A, from Salida to Oakdale (III—Sta.—13–A): Surveys completed. Length, 14.4 miles.

SECTION B, from Oakdale to the northeast boundary of Stanislaus County (III—Sta.—13–B): Surveys completed. Length, 12.9 miles.

SUTTER COUNTY.

Division III, Route 3.

SECTION A, from Yuba City to the Sutter-Butte County line (III—Sut.—3–A): Laid out as State Highway Nov. 10, 1914. Bids received Dec. 14, 1914. Award pending. Pavement, oiled concrete, 15 feet wide.

TEHAMA COUNTY.

Division II, Route 3.

SECTION A, from the south boundary of Tehama County to Los Molinos (II—Teh.—3–A): Surveys, plans and estimates completed. Bids received July 6, 1914, for construction of Portland cement concrete, and rejected. Length, 10.6 miles.

SECTION B, from Tehama Junction to Red Bluff (II—Teh.—3–B): Surveys completed. Plans and estimates in progress. Length, 10.8 miles.

SECTION C, from Red Bluff to the north boundary of Tehama County (II—Teh.—3–C): Surveys, plans and estimates completed. Length, 14 miles.

Route 7.

SECTION A, from the south boundary of Tehama County to a point west of Tehama Junction (II—Teh.—7–A): Surveys completed. Length, 15.3 miles.

A_1, from the south boundary to Corning: Laid out as State Highway April 22, 1914. Contract (No. 76) awarded June 9, 1914, to Jacinto, Burns & Da Roza. Length, 8.8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $84,255; per mile, $9,585. Amount of contract completed to Dec. 12, 1914, 81.3 per cent.

Plans and estimates on the remaining portion of the section are practically completed.

TRINITY COUNTY.

Division II, Route 20.

SECTION A, from Weaverville to the Trinity River (II—Tri.—20–A): Surveys in progress. Length, 13 miles.

SECTION B, from the Trinity River to the east boundary of Trinity County (II—Tri.—20–B): Survey ordered. Length, 11 miles.

TULARE COUNTY.

Division VI, Route 4.

SECTION A, from the south boundary of Tulare County to a point between Pixley and Tipton (VI—Tul.—4–A): Surveys completed and plans in progress. Length, 15.2 miles.

SECTION B, from a point between Pixley and Tipton to Tulare (VI—Tul.—4–B): Surveys completed and plans in progress. Length, 12.7 miles.

SECTION C, from Tulare to Goshen (VI—Tul.—4–C): Surveys completed. Plans and estimates partially completed. Length, 9.3 miles.

C_1, laid out as State Highway April 22, 1914. Length, 4.3 miles.

No Section D.

SECTION E, from Goshen to the north boundary line of Tulare County (VI—Tul.—4–E): Laid out as State Highway Jan. 21, 1914. Length, 13.7 miles.

Route 10.

SECTION A, between Visalia and the west boundary of Tulare County (VI—Tul. 10–A): Surveys, plans and estimates completed. Length, 9.2 miles.

TUOLUMNE COUNTY.

Division III, Route 13.

SECTION A, from the southwest boundary of Tuolumne County to a point 2 miles north of Keystone (III—Tuo.—13–A): Laid out as State Highway Jan. 21, 1914. Bids received and rejected March 30, 1914. Being constructed by the state by day labor (No. D6). Length, 10.9 miles. Road to be graded 18 feet wide. Probable total cost, $48,550; per mile, $4,475. Amount of contract completed to Dec. 12, 1914, 82.2 per cent.

SECTION B, from a point two miles north of Keystone to Sonora (III—Tuo.—13–B): Surveys complete. Plans in progress. Length, 11.3 miles.

VENTURA COUNTY.

Division VII, Route 2.

SECTION A, from the Ventura-Los Angeles County line to Newbury Park (VII—Ven.—2–A): Laid out as State Highway March 26, 1913. Bids received and rejected, April 21, 1913. Bids received May 19, 1913. Contract (No. 31) awarded May 21, 1913, to Leigh G. Garnsey. Length, 7.3 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $71,525; per mile, $9,740. Contract completed.

SECTION B, from Newbury Park to Springville (VII—Ven. 2-B): Laid out as State Highway June 23, 1914. Contract (No. 81) awarded July 7, 1914, to Leigh G. Garnsey. Length, 11.1 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $144,750; per mile, $12,990. Amount of contract completed to Dec. 12, 1914, 35.8 per cent.

SECTION C, from Springville to Ventura (VII—Ven.—2-C): Surveys completed. Plans in progress. Length, 10.2 miles.

SECTIONS D and E, D from Ventura to Padre Juan Canyon, and E from Padre Juan Canyon to Sea Cliff (VII—Ven.—2 D and E): Laid out as State Highway Jan. 21, 1914. Contract (No. 52) awarded Feb. 26, 1914, to Carl Leonilardi. Length, 8 miles. Pavement, oiled concrete, 15 feet wide. Probable total cost, $109,645; per mile, $13,670. Work practically completed.

SECTION F, from Sea Cliff to Rancho El Rincon (VII—Ven. 2-F): Laid out as State Highway Aug. 27, 1912. Length, 4.4 miles. This section includes a long timber trestle which was taken over by the state. See Section G.

SECTION G, from Rancho El Rincon to the Ventura-Santa Barbara county line (VII—Ven.—2-G): Laid out as State Highway March 25, 1914. Contract (No. 73) awarded for Sections F and G, June 9, 1914, to Modern Construction Co. Length, 5 miles. Pavement, 15 feet wide, oiled concrete, not including the trestle. Probable total cost, $52,195; per mile, $10,330. Amount of contract completed to Dec. 12, 1914, 66.4 per cent.

SECTION H, alternate route from foot of Conejo grade to Oxnard, length, 10.1 miles; and SECTION I, alternate route from Oxnard to El Rio. Length, 2.2 miles. Survey completed.

YOLO COUNTY.

Division III, Route 6.

SECTION A, from 2 miles west of Davis to Southern Pacific bridge 81 A (III—Yol.—6-A): Surveys completed. Plans in progress. Length, 7.5 miles.

SECTION B, from Southern Pacific bridge 81 A to West Sacramento levee (III—Yol.—6-B): Laid out as State Highway April 22, 1914. Contract (No. 86) awarded July 21, 1914, to the Graff Construction Co. Probable total cost, $392,810; per mile, $127,120. Length, 3.1 miles. The road is wooden trestle for about 0.4 mile, and reinforced concrete trestle with draw-span for about 2.7 miles. Amount of contract completed to Nov. 28, 1914, 7.1 per cent.

SECTION C, from West Sacramento levee to the Sacramento River (III—Yol.—6-C): Surveys completed. Plans in progress. Length, 3.9 miles.

Route 7.

SECTION A, from the south boundary to Woodland (III—Yol. 7-A): Laid out as State Highway June 23, 1914. Contract (No. 82) awarded July 7, 1914, to M. Blumenkranz. Length, 11.8 miles. Pavement, oiled concrete 15 feet wide. Probable total cost, $102,290; per mile, $8,710. Amount of contract completed to Dec. 12, 1914, 43.1 per cent.

SECTION B, from Woodland to Blacks (III—Yol. 7-B): Surveys completed. Plans in progress. Length, 11.0 miles.

SECTION C, from Blacks to the north boundary of Yolo County (III—Yol.—7-C): Surveys completed. Plans in progress. Length, 11 miles.

YUBA COUNTY.

Division III, Route 3.

SECTION A, from the south boundary line of Yuba County to Morrison's Crossing (III—Yub.—3-A): Laid out as State Highway July 21, 1914. Pavement, oiled concrete 15 feet wide. Length, 3.3 miles. Bids received Aug. 31, 1914, and rejected; further bids will be received.

SECTION B, from Morrison's Crossing to Marysville (III—Yub.—3-B): Laid out as State Highway May 21, 1912. Contract (No. 4) awarded July 23, 1912, to F. E. Frey. Length, 9.2 miles. Pavement, oiled macadam, 15 feet wide. Probable total cost, $67,688; per mile, $7,341. Contract completed.

TABLE OF CONTENTS

Page

Alameda County, progress in ... 17
Alpine County, study of route in ... 4, 17
Amador County, study of route in ... 4, 17
Asphaltic Concrete ... V. E. LODER ... 14
Building California's State Highway ... 10
Building Mountain Roads, *illustration* ... 9
Building State Highway through Forest, *illustration* ... 11
Butte County, progress in ... 17
Calaveras County, study of route in ... 4, 18
California Concrete Road, A ... JAMES B. WOODSON ... 12
California Meeting Oregon, *illustrated* ... 6
Cautionary Signs ... 4
Cautionary Signs, *illustration* ... 15
Colusa County, progress in ... 18
Completed Roads, *illustration* ... 5
Contra Costa County, progress in ... 18
Del Norte County, progress in ... 18
Division Engineers, list of ... 24
El Dorado County, progress in ... 18
Fresno County, progress in ... 18
Glenn County, progress in ... 18
Heads of Departments, Highway Commission ... 24
Humboldt County, progress in ... 18
Imperial County, progress in ... 18
Inyo County, study of route in ... 4, 18
Kern County, progress in ... 18
Kings County, progress in ... 19
Lake County, progress in ... 19
Lassen County, progress in ... 19
Lateral Road Problem, The ... 6
Los Angeles County, progress in ... 19
Madera County, progress in ... 19
Map ... 24
Marin County, progress in ... 19
Mariposa County, progress in ... 19
Materials, State Highway ... 6
Mendocino County, progress in ... 19
Merced County, progress in ... 19
Modoc County, study of route in ... 4, 19
Mono County, study of route in ... 4, 19
Monterey County, progress in ... 19
Motor Car Clearance on State Highway, *illustration* ... 3
Mountain Road Construction, *illustration* ... 9
Mountain Roadways ... 2
Napa County, progress in ... 20
Nevada County, reconnoissances made ... 20

Page

Offices of Commission ... 24
On the Coast Route, *frontispiece* ... 1
Orange County, progress in ... 20
Placer County, progress in ... 20
Plumas County, study of route in ... 4, 20
Principal Highway Routes, *with map* ... 24
Progress Record ... 17-22
Protecting the Public ... CHAS. F. STERN ... 3
Rincon Road Trestle, *illustration* ... 16
Rights of Way ... AUSTIN B. FLETCHER ... 7
Riverside County, progress in ... 20
Road Oil Specifications ... 16
Roads, lateral ... 4, 6
Routes, State Highway ... 17
Sacramento County, progress in ... 20
Safeguards in Highway Contracts ... 3
San Benito County, progress in ... 20
San Bernardino County, progress in ... 20
San Diego County, progress in ... 20
San Francisco, State Highway routes touching ... 20
San Joaquin County, routes in ... 20
San Luis Obispo County, progress in ... 21
San Mateo County, progress in ... 21
Santa Barbara County, progress in ... 21
Santa Clara County, progress in ... 21
Santa Cruz County, progress in ... 21
Savings from Good Roads ... 11
Seawall on Rincon Route, *illustration* ... 7
Shasta County, progress in ... 22
Sierra County, study of route in ... 4, 22
Siskiyou County, progress in ... 22
Solano County, progress in ... 22
Sonoma County, progress in ... 22
Stanislaus County, progress in ... 22
State Highway Progress ... 2, 17
Studying Mountain Laterals ... 4
Sutter County, progress in ... 22
Tehama County, progress in ... 22
Temporary Roads ... 22
Trinity County, progress in ... 22
Tulare County, progress in ... 22
Tuolumne County, progress in ... 22
Types of Bridges and Culverts, *illustration* ... 13
Ventura County, progress in ... 22
Yolo County, progress in ... 23
Yuba County, progress in ... 23

STATE OF CALIFORNIA
DEPARTMENT OF ENGINEERING

CALIFORNIA HIGHWAY COMMISSION

CHARLES D. BLANEY, Chairman
NEWELL D. DARLINGTON
CHARLES F. STERN

Headquarters of the Commission: Forum Building, Sacramento.

AUSTIN B. FLETCHER, Highway Engineer.
GEORGE R. WINSLOW, First Assistant Highway Engineer.
LESTER H. GIBSON, Seeond Assistant Highway Engineer.

WILSON R. ELLIS, Secretary.
CHARLES C. CARLETON, Attorney.
H. L. WARREN, Purehasing Agent.
JOHN H. SMALL, Chief Aeeountant.
CLARENCE B. OSBORNE, Geologist.
GEORGE B. HARRISON, Chief of Right of Way Department.

DIVISION I. F. G. Somner, Division Engineer; F. W. Haselwood, Prineipal Assistant Engineer; Mereantile Building, Willits.

DIVISION II. T. A. Bedford, Division Engineer; R. H. Stalnaker, Prineipal Assistant Engineer; H. S. Comly, Assistant Division Engineer; Dunsmuir.

DIVISION III. W. S. Caruthers, Division Engineer; T. E. Stanton, Jr., Assistant Division Engineer; S. S. Stahl, Assistant Division Engineer; Forum Building, Saeramento.

DIVISION IV. A. E. Loder, Division Engineer; R. K. West, Principal Assistant Engineer; Rialto Building, San Franeisco.

DIVISION V. W. C. Howe, Division Engineer; George Mattis, Assistant Division Engineer; A. A. Peters, Assistant Division Engineer; Union National Bank Building, San Luis Obispo.

DIVISION VI. J. B. Woodson, Division Engineer; D. W. Chamberlain, Assistant Division Engineer; Rowell Building, Fresno.

DIVISION VII. W. L. Clark, Division Engineer; S. V. Cortelyou, Assistant Division Engineer; W. W. Pateh, Assistant Division Engineer; Union Oil Building, Los Angeles.

Roads shown on the map in the vicinity of Lake Tahoe have been built by the State Department of Engineering under special appropriations.

Principal Highway Routes

The map shows the main routes in the State Highway system, but does not indieate the laterals on which reconnoissanees have been ordered, but which have not as yet been advanced to the point of loeation surveys or layouts. The details of these routes and the results aeeomplished are set forth in the Progress Reeord given in this number of the Highway Bulletin. The map is not as fully correeted as the record, but it shows in a general way the routes through the and along the coast, and, if taken in conneetion with the hils, as arranged by counties, will give a good idea of the e in State Highway construetion. The division into which State has been arranged for State Highway work are indieated by ines. Apparent gaps, in Sacramento, San Joaquin, Santa Los Angeles counties indicate improved roads already eonparts of county systems.

NOTE.—This Bulle

CAL

One of the many heavy

ARTICLES

To the People of California (A
What Will be Done With the $18,
Fund
What Will be Done With the $15,
Everybody's Roads
Overhead
State Highway Bridges
The Great Short Cut Over Tehac
Mr. Pennybaker on California Hi

NOTE.—This Bulletin is a "folder," doubled lengthwise with large map inside. As folded the pages are in consecutive order.

CALIFORNIA HIGHWAY BULLETIN

SACRAMENTO, CALIFORNIA, JULY 1, 1916 FIFTH ISSUE

One of the many heavy cuts on the Castaic Ridge Route between Bakersfield and Los Angeles, depth 110 feet. Over one million cubic yards of excavation were necessary in the construction of two sections of this road.

TABLE OF CONTENTS

ARTICLES

	Page
To the People of California (A Statement)	Inside
What Will be Done With the $18,000,000 Bond Fund	Inside
What Will be Done With the $15,000,000 Issue	Inside
Everybody's Roads	Inside
Overhead	2
State Highway Bridges	2
The Great Short Cut Over Tehachapi Mountains	3
Mr. Pennybaker on California Highways	4
Eliminating the Terrors of Bell Springs Grade	5
The Yolo Basin Trestle	6
Convict Labor on the State Highways	7
Highway Bonds Sold to Counties	8

ILLUSTRATIONS

	Page
Progress Map State Highway System	Inside
Weber Creek Bridge, Old and New	2
Glimpses on Ridge Route	3
Bird's-eye View Castaic Ridge Road	3
Map Bakersfield to Los Angeles	3
State Highway Steam Shovel in Action	4
Pit River Bridge	4
Before and After	4
A Stretch of Mendocino Highway	5
Cuts, Fills and Culverts	5
Yolo Basin Trestle	6
Map Yolo Basin Trestle	6
Convict Workers on State Highway	7
Panorama San Luis Obispo County	8
"Safety First"—Underpass	8
The Difference	8

CALIFORNIA HIGHWAY BULLETIN

PUBLISHED BY THE

CALIFORNIA HIGHWAY COMMISSION

OF THE

Department of Engineering

State of California

CHAS. D. BLANEY, Chairman

N. D. DARLINGTON · · CHAS. F. STERN

Commissioners

AUSTIN B. FLETCHER, Highway Engineer

GEORGE R. WINSLOW, Assistant Highway Engineer

CHAS. C. CARLETON, Attorney

W. R. ELLIS, Secretary

Forum Building, Sacramento, California

DIVISION ENGINEERS—OFFICE ADDRESSES:

Division I. F. G. SOMNER. · · ·

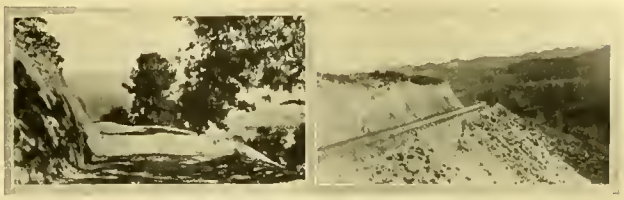
THE GREAT SHORT CUT OVER TEHACHAPI MOUNTAINS

How the Tejon-Castaic Ridge Road between Bakersfield and Los Angeles was Located and Constructed

One of the biggest engineering problems that challenged the Highway Commission at the inception of its work was the location of the trunk road between Los Angeles and Bakersfield.

The only highway between the San Joaquin Valley and the southern metropolis lay in part through the Mojave desert, and the distance between Los Angeles and Bakersfield via Tehachapi, the desert and Mint Canyon was about 170 miles. The so-called Tehachapi route traversed two mountain ranges, reaching an elevation of nearly 4,000 feet between Saugus and Palmdale, dropped 1,500 feet into Mojave desert and again climbed steep grades to an elevation of about 4,000 feet at Tehachapi. If one chose the Tejon Pass for the northerly part of his journey, he also had rough roads and steep grades to contend with.

Most people assumed that the state highway would follow the Tehachapi route, but consistent with its policy to build the state highways



Glimpses Along the Castaic Ridge Road.

by the most direct and practicable routes, the Commission determined at the outset to explore Tejon Canyon and the ranges and ridges to the south for a shorter, easier, and more scenic highway into the southland.

A preliminary study and reconnaissance made by W. Lewis Clark, then Division Engineer at Los Angeles, dissipated all doubt as to the feasibility of the enterprise, and to his able, painstaking work much credit must be accorded.

On January 25, 1912, surveys were ordered over lines closely following the present location of the Castaic Ridge route.

The so-called Ridge route begins at a point near Saugus in the northerly part of Los Angeles County, and by easy grades, in no place exceeding 6 per cent, climbs up on what is known as the Castaic Ridge. For a distance of about 29 miles, the state highway follows on the Ridge, winding from one side to the other through the saddles but keeping substantially the elevation attained. Near the northerly end, after passing Liebre Mountain, the road descends to Bailey's ranch. From this point on, the highway follows the Tejon Pass, via Lebec, and comes out into San Joaquin Valley at a point near Rose Station.

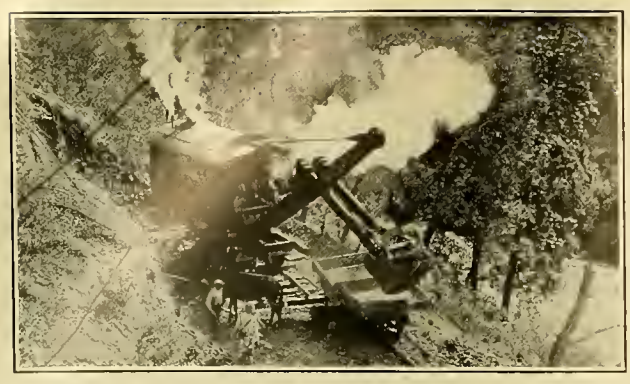
Bird's eye view of the Castaic Ridge Route between Bakersfield and Los Angeles.

The Tejon Pass had for many years been the competitor of the Tehachapi route between Bakersfield and Bailey's ranch and had been preferred by many to the Tehachapi, but by means of judicious relocations and grade changes in the Tejon Pass a great transformation has been worked. Whereas there were formerly grades as steep as 20 per cent, there is now no grade in excess of 6 per cent, and this is smooth and hard and safe.

Only the person who saw the country through which the road south of Bailey's passes in its native wildness can realize the magnitude of the undertaking. Chopping their way through the brush, clinging to the precipitate walls of canyons where no pack mule could keep his feet, across ravines and along the crests of the mountains, the surveyors fixed their stakes, and, link by link, laid the lines along which this mighty highway should run.

It is still another story of thrills—the story of how the construction contractors attacked these forbidding mountain ranges with but trails by which to transport their machinery to the work; how storms in winter and dearth of water in summer; how landslides, boggy adobe, and granite walls made their task a gigantic struggle between human wit and courage on the one hand and nature's untamable elements upon the other.

Enraptured by the panoramic beauty of the scenery at every dip and turn of the road, the traveler is lulled into happy forgetfulness of the



A State Highway Steam Shovel in Action.

fact that but a few brief seasons since where he now rides in cushioned and upholstered luxury, mountain goats and coyotes monopolized the solitudes of these perpendicular canyon walls and mountain ledges.

Whereas the old "roundabout" Tehachapi route climbed by steep grades to an altitude of 4,000 feet, then dropped 1,500 feet into Mojave

CALIFORNIA HIGHWAYS MOST NOTABLE IN U. S.

"I have just returned from a thousand-mile tour of California highways, more than six hundred miles of which traversed the State system of trunk lines. With due regard for the great work already completed and under way in the Eastern states, I predict that the California highway system, now in the making, will be, when completed, the most notable system of highways in America, if not in the world."—J. E. PENNYBAKER, Chief of Road Economics, United States Office of Public Roads.

The San Francisco *Chronicle* of recent date gives the following picturesque description of this Castaic Ridge road:

"One of the most remarkable engineering feats accomplished by the State Highway Commission, and one which will prove of incalculable value to the San Joaquin Valley and southern California, was accomplished recently when the new ridge route between Saugus and the Tejon Pass was thrown open for travel. Cutting off forty-five miles of the distance between Los Angeles and San Francisco, it provides the shortest route between San Francisco and the southern metropolis.

"Thirty miles of this road is in the wildest of southern California's mountain country, a section previously known to only a few ranchers and oil companies.

"But the motorist is little aware that he is rapidly climbing to the 'top of the world' in the first stretches of this wonderful route, for the gradient is so easy that few indeed are the cars which can not make the drive on high gear. After the road attains the ridge between Castaic and Piru canyons it follows the top of the hills in a remarkable series of curves and cuts, which entirely do away with the old 30 per cent grades which took the stamina out of a motor on the Midway route.

"'It skirts 1,000-foot precipices. It disappears within cuts that are tunnel-like in their depth. It spirals to gain the upper altitudes so that the traveler catches a glimpse of the roadway at a half dozen different levels. It is southern California's *magnus opus* in mountain highway construction.'"

The Pit River Bridge near Baird, Shasta County. It lacks only a few feet of having the longest concrete arch west of the Rockies.

desert, and then climbed up and down the steep and tortuous Tehachapi grades to an altitude of 4,000 feet, putting about 170 miles between Bakersfield and Los Angeles, this new Castaic Ridge route by easy grades and gracefully-sweeping curves, reaches its highest elevation of 4,233 feet on the Los Angeles side, then descends by gentle grades 1,100 feet to the western rim of Antelope Valley, thence gradually climbs the Tehachapi range and crossing it at an elevation of 4,200 feet at Tejon Pass, thence via Tejon Canyon, it makes a veritable "bee line" for Bakersfield.

Between Newhall in Los Angeles County and Bakersfield in Kern, the point of greatest divergence from a straight line is in Tejon Pass, and there it is only about 7 miles southwest of an air line.

From 45 to 60 miles of a toilsome desert and rough mountain road are eliminated between Bakersfield and Los Angeles, and in no place between the two cities is it necessary to use any but the high gear.

The distance by the Tejon-Castaic Ridge route, between the points named, is almost exactly 124 miles.

On page 1 of this bulletin appears a picture of one of the numerous heavy "cuts" that were made in the construction of this road. It has been called the state highway's "Culebra" excavation. It has a depth of 110 feet. On two sections alone of this work more than a million cubic yards of earth and rock were moved. Large cuts along steep mountain sides and through the saddles between peaks ran up the cost of construction but vastly reduced the mileage.

In thus shortening the distance and reducing the grades, the Castaic Ridge route has already become a great and powerful influence in promoting the unity and integrity of heretofore divided sections and in discouraging state division agitation.

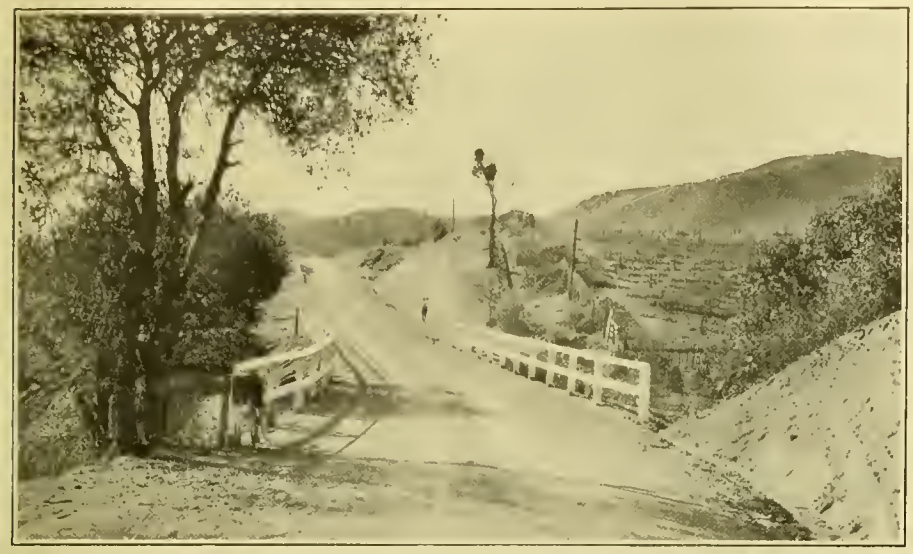
Of the whole distance between Los Angeles and Bakersfield there remains but about 34 miles unpaved. Whether or not these remaining miles shall be paved like the rest of the highway is dependent upon the action of the voters next November on the proposed new bond issue for state highways.

Before and After; Showing Locating Highway Surveyors at Work Where Later the New Road Appears—State Highway, Shasta County.

ELIMINATING THE TERRORS OF THE BELL SPRINGS GRADE

What the New State Highway via the South Fork of Eel River Means to Humboldt and Mendocino Counties

The city of Eureka, situated on Humboldt Bay, in central Humboldt County, has a population of 15,000. The Northwestern Pacific Railroad was completed to Eureka in August, 1914. Prior thereto this city had the distinction of being the largest city in the United States without railroad communication. The growth of a city to this size under such adverse conditions is unprecedented. Eureka may be justly proud of its achievement, which is not only a monument to its enterprising citizenship but indisputable evidence of the wonderful resources of Humboldt County.



A Stretch of Mendocino State Highway.

Still more wonderful is the fact that this stage of development has been reached without even all-year-round wagon road communication. In fact, Eureka can be reached even during the summer months only under the most strenuous conditions, by means of a public road from San Francisco over the summit of the Bell Springs mountain, the elevation of which is 4,100 feet above sea level.

After the first rains, which generally occur in October, this road is impassable for motor vehicles and even for horse-drawn vehicles. When snowstorms set in transportation is limited to saddle and pack animals.

The beginning of the ascent on the south slope is at Cummings, a post office at the foot of "Rattlesnake Grade." The elevation is 1,414 feet. A climb of 2,686 feet is made up and down grades exceeding 20 per cent, to the summit, which is distant 12 miles, to an elevation of 4,100 feet. From this point a descent of 3,937 feet is made on up and down grades, some of them as high as 30 per cent, to the town of Dyerville, distant 46 miles from the summit, elevation 163 feet.

The distance across this spur of the Coast Range mountains is 58 miles. Although the high altitudes on the route afford a splendid view of the surrounding country in all directions, the tourist and wayfarer would willingly forego the scenic advantages of the Bell Springs mountain to travel a less strenuous route.

But the terror of the Bell Springs mountain will, in the near future, it is hoped, exist only in memory. This pioneer highway of northern California is to be superseded by the northern extension of the coast line of the state highway system.

For the past twenty years the elimination of the Bell Springs mountain grades by means of a road following either the Eel River or its South Fork has been the dream of the enterprising citizens of Humboldt County. At one time the solution of this problem was thought to have been reached through the co-operation of the counties of Humboldt and Mendocino; but upon making the reconnaissance of the routes the engineers were confronted by many physical obstructions, which so discouraged the supervisors of the two interested counties that the project was abandoned.

The California Highway Commission immediately upon assuming their duties ordered a reconnaissance of the several routes, which resulted in the selection of the South Fork route. This action has elicited unanimous approval.

It is doubtful whether the completion of any stretch of road in the State is looked forward to locally and also by the general public with more eagerness than the gap between Cummings and the Humboldt County line, a distance of 29.3 miles.

From Cummings the route lies down the Rattlesnake Creek to its junction with the South Fork of the Eel River, thence down the east bank of the river to its junction with the main Eel River at the town of Dyerville.

The elevation at Cummings is 1,414 feet, and the descent is on a gradual grade not exceeding 6 per cent, to Dyerville, elevation 163 feet, the distance from Cummings to Dyerville being 69 miles. As this change in the route of the San Francisco and Eureka overland road means the elimination of 2,686 feet of heavy grades, its importance may be readily conceived.

That portion lying between Dyerville and Miranda, distance 14 miles, and between Garberville and the Mendocino-Humboldt county line, distance 11 miles, has already been constructed, having a roadbed varying in width from 16 to 20 feet. The gap of 29.3 miles between Cummings and the Humboldt-Mendocino county line is now in the course of construction by prison labor.

This construction entails the erection of several bridges of a formidable nature, among which are Cedar Creek bridge, 350 feet in length, 135 feet in height; Rock Creek bridge, 210 feet in length, 145 feet in height; and the two crossings of the South Fork of the Eel River, each 350 feet in length.

The presence of forests of redwood timber along the route, and the remoteness of the locality, made it inadvisable to incur the expense of transporting steel and cement, and induced the Highway commission to adopt timber bridges of modern design. Preparations for their construction are now going forward.

The country traversed is in a virgin state, for the most part devoid of wagon roads or even passable trails except those made within recent years by the state highway surveyors. Until recently much of the land was not open for entry, so the country between Cummings and the Humboldt-Mendocino county line is settled principally by homesteaders, although there are a few spots that have been under cultivation for several years.

The scenery is unsurpassed in California and the redwood forests, river views and picturesque ruggedness will be a revelation to the tourist. It is needless to say that the opening of this stretch of road will be one of the notable events in the history of Mendocino and Humboldt counties, and will create as much interest as was manifested at the opening of the Northwestern Pacific Railroad between Willits and Eureka.

Cuts, Fills, and Culverts—State Highway Construction, Santa Barbara County.

On another page the story of the progress of the prison labor camps on this work is graphically told.

STORY OF THE GREAT YOLO BASIN CONCRETE TRESTLE

It Bridges over Three Miles of Marsh Lands and Unites the East and West Sides of Sacramento Valley

The completion of the Yolo Basin Trestle by the State Highway Commission was the occasion of a celebration May 11 to 14, 1916, in which practically the entire Sacramento Valley participated in the formal opening and dedication of this, the longest concrete trestle in the world.

For forty years the people of Sacramento Valley had been dreaming of the day when the basin would be permanently bridged, and at last the dream has come true.

occasion of an event comparable in spirit and enthusiasm with the celebration of the opening of the Panama Canal by the nation last year. For in truth, in a local way, the Yolo Basin Causeway is even of larger significance to Sacramento Valley and Central California than the Canal is to the country at large, slides or no slides.

The building of this trestle of concrete was in pursuance of the policy of the California Highway Commission to construct the state highway system in a durable manner, and choose routes that would

The Yolo Basin Concrete Trestle, over three miles long and costing about $400,000.

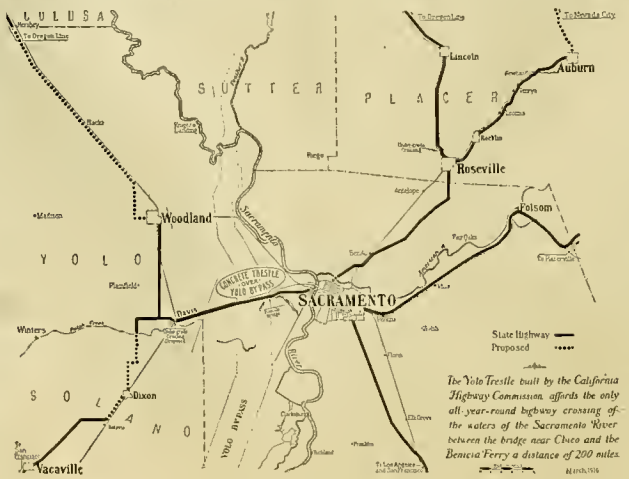
The so called Yolo Basin is flooded annually for six or eight months, and is a part of the great marshy district extending from a point some fifteen miles north of Marysville to Rio Vista, a distance of more than 120 miles. The flooded territory is as wide as three miles in places.

South of the bridge at Meridian, which lies due west of Marysville, there has been no way of crossing the overflowed area in vehicles during the flood periods; and the east and west sides of the great Sacramento Valley have had no means of intercommunication by highway at such times.

For a few months during summer and fall when the flood waters from the Sacramento have subsided and the marsh lands have dried out somewhat, a precariously passable road, known as the "Tule Jake" road, was the only means of crossing the Basin.

It is unnecessary to say that "Tule Jake's" road was usually a concatenation of ruts and chuckholes.

Thus the reader from a distance may readily understand how the social and commercial interests of the Capital City have been hemmed in and how the farmer on the other side has been denied access to the market center of California by this great Yolo Basin, and he no longer wonders that the building of a solid concrete trestle with asphaltic pavement across the marsh was the



most directly and strategically connect the centers of population, regardless of engineering difficulties and false theories of economy in first cost.

The design of this trestle was worked out by the engineering forces in the Commission's office in Sacramento.

The westerly 2,000 feet of the trestle is of timber construction for the reason that some day a levee to define the westerly margin of the Yolo By-pass is to be built. Thereafter an earth fill may be substituted for the wooden trestle.

Including this wooden portion, the entire trestle is over three miles in length, and is reported as stated to be the longest trestle in the world. Its average height is 20 feet and it provides a clear driveway of 21 feet in width.

The contract for the work was let July 31, 1914. Driving the wooden piles on the west end began November 1st of that year, and the first concrete pile was driven on January 3, 1915, and the last on October 1, 1915.

On Saturday, March 18, 1916, the general public was given the first and long looked for opportunity to use the trestle; and on the following day over 2,000 automobiles, conveying 8,000 people, traveled over it.

Nearly 1,100 carloads of material were used in the construction of this great bridge, including 21,692

tons of crushed stone, 12,553 tons of sand, 32,000 barrels of cement and 2,200 tons of reinforcing steel. These materials, which cost $148,000, were supplied by the Commission under its special half-rate freight schedule agreement with the railroad company.

The contractors, the Graff Construction Company of Seattle, received $246,000 under their contract. The total cost of the trestle was therefore a little under $400,000.

The trestle, as shown by the accompanying illustration, is a structure resting upon reinforced concrete piles from 32 to 50 feet long, driven in groups of four abreast, called "bents," to an average depth of 20 feet. These piles are 14 inches square, the lower five feet being tapered to facilitate driving. They weigh from three to five and one-half tons each, according to length.

They were conveyed from the casting grounds to position by a narrow gauge railroad, especially built by the contractors for the purpose. The piles were cast with the ends of the heavy steel reinforcing bars projecting two feet from their tops. The two inside piles of each "bent" were driven vertical, the outside piles were sent down at a slant, giving the structure a widened and a braced foundation.

Each group of four piles is capped and bound together by a concrete cap. This cap is reinforced by heavy steel rods, and is cast in place, forming a solid monolithic member, with the projecting ends of the steel reinforcing bars of the piles embedded and anchored into the cap when cast.

Spanning the 20 feet from "bent" to "bent," the reinforced concrete floor slabs were placed directly upon the caps. These slabs weigh about six tons each. They are formed like a huge inverted box with side and end walls eighteen inches high and top six inches thick. Five of these slabs, side by side, bound by reinforcing steel and cement to the caps, form a practically solid stone structure three miles in length.

The precision of the lines and grades of the trestle have been favorably commented upon by many who have closely examined the work. As the piles and the guardrail stretch away out of sight across the watery wastes, one marvels at the skill displayed in driving the great concrete piles with such unvarying accuracy and at the assembling of all the bulky parts into a complete whole so that its lines and grades are as true as if the structure had been cast as a monolith.

This trestle, together with the connecting roadways, reduces the distance from Sacramento to San Francisco by automobile to 98 miles, a saving of 30 miles via Stockton and Altamont.

The run to Davis from Sacramento may be easily covered by auto in half an hour, and Woodland is now brought to within fifty minutes' driving time from the Capitol.

There is a double satisfaction to the public in knowing this very important and necessary structure, which would be cheap at almost any price, has been finished in the most creditable manner at a cost that under the present war market conditions would cost many thousands of dollars more than the State has paid for it.

Incidentally, this trestle stands as a very striking physical exhibit of the California Highway Commission's methods in disbursing the state highway funds.

CONVICT LABORERS ON THE MOUNTAIN LATERALS

They Are Building Roads of a Character and in Places that Otherwise Would Not Be Built

Convict labor on state highways is one of the solvents for California's tremendous mountain road problem.

Ever since the "days of old, the days of gold," which Bret Harte describes as "heaven for men and dogs, but hell for women and children," the mountain road problem of California has been beyond her resources. For years to come it must be so.

The convict building such roads takes work from no man, but does work that otherwise could not be done; makes available acres for the landless that otherwise would not be opened; stirs up counties to local road improvement that increases vastly the sum total of road work open for the free road builders of California.

The intent of the convict labor law is to build roads of a character and in locations that otherwise are beyond the resources of the State.

No better description could be given of the laterals demanded by the Highway Act to connect the trans-Sierra county seats with the trunk line in the valley. Unfortunately where people and land values are not, road costs are highest. And the needs of these mountain communities, blocked by snow from the balance of the State for half the year, are the most acute. Yet this is the part of California that should be the playground of the nation, and a tremendous financial asset to the State.

On the other hand is the prison population of the State: 4,000 men—outcasts, hopeless—a financial and social burden.

In California at least this is a problem of young men, their average age less than thirty, men who are coming out to live the greater part of their lives as increasing assets or liabilities.

The convict labor law brings the need and the man together, on a working basis that appeals to both.

The law became effective last August. In September the first camp of thirty men was established in northern Mendocino. The scope of the work was gradually enlarged, on a safety first basis. We carried two camps with 125 men through the winter, working every day but Sunday, through a rain and snow fall of seventy inches. The men have been given sanitary camps that probably surpass and food that at least equals the best free labor camps. We have given them better living and working conditions, a large measure of personal freedom and under the law the crowning incentive of one day's reduction of sentence for every two days of loyal work.

The laying out and direction of the work has been in the hands of the Highway Commission, as well as providing camps, commissary, etc. The discipline of the men has been in the hands of the Board of Prison Directors, represented by three guards without arms in each camp—one acting as captain of the camp, the others as subforemen on the work.

To the intelligent co-operation of these two departments of the state is due the conspicuous success of the scheme.

The humanitarian side of the work is self evident. The men are immeasurably bettered physically, which means mentally and morally. Constructive work instead of the jute mill, under blue skies and among the beauties of mountain California instead of behind stone walls, co-operating with the state instead of being outcasts of the state—these things are alone worth the doing.

But there is another side without which the scheme would not solve the problem for which it is intended.

These men have come soft from prison to a new work under almost impossible weather conditions. We have supplied them with every-

Convict Workers on the Mendocino-Humboldt Highway.

thing they have or use—clothing, transportation, guards, food, beds, medical attention, as well as the ordinary expense for materials and equipment for road work—all this many miles from transportation—and the winter's work shows a profit.

Through the winter eight miles of difficult canyon road has been built for 25 per cent less than the estimate, and little more than half what similar work has cost on contract in the same locality. As weather conditions improve costs are falling and yardage increasing.

The success of the work in Mendocino led to the placing of a crew from Folsom on a section of the Placerville road, near Shingle Springs. Only an inadequately small amount of maintenance funds were available for this section, but this expedient will give the equivalent of $18,000.00 in work for an expenditure of $5,000.00, and make possible an improved section of a needed road which otherwise must have waited for the next bond issue.

The Commission is now preparing to attack the Sierra lateral question by placing convict camps on each of four of these roads for active construction this summer.

The experimental stage of this scheme is passed.

There is no longer a question that convict labor is not only successful as a humanitarian measure, but that it will make possible the construction of many miles of mountain roads that otherwise could not be built.

Panorama on state highway near Santa Margarita, San Luis Obispo County.

SALES HIGHWAY BONDS TO COUNTIES

The campaign which the Commission inaugurated to induce the counties to buy highway bonds made slow headway for many months and only by the aid of a few live and active spirits in scattered sections did the movement make a start.

The first sales of bonds were negotiated by individual citizens and chambers of commerce.

The Commission backed the introduction of a special legislative enactment at the session of 1913 which specifically empowered the supervisors of any county to invest their surplus county funds in state securities. Under this act, one by one, the counties began to negotiate with the Commission for bonds and highways.

"Safety First" (Ventura County)—One of Many Underpasses on the State Highway.

When the Commission began to refuse to apportion the amounts of bonds clamorously asked for by some of the counties, when it became apparent that there was not enough to go around, a veritable scramble ensued among the counties to "get in on" what was left.

As a consequence many communities were sorely disappointed. But in Grover Cleveland's words, "it was a condition and not a theory" which the State's highway enterprise was facing. Like sympathetic friends at a funeral, the Commissioners could only say to the mourners, "We are sorry for you."

Below is a tabulation of the amounts of bonds sold to the various counties. The statement shows:

Total amount of bonds bought by counties.....$13,720,000
Total amount of bonds sold independently..... 4,280,000 $18,000,000

Sales Highway Bonds to Counties.

Division I.			**Division IV—Cont.**		
Humboldt	$600,000		Santa Cruz	135,000	
Mendocino	445,000	$1,045,000	San Mateo	325,000	
Division II.			Sonoma	220,000	$2,293,000
Shasta	$205,000		**Division V.**		
Siskiyou	225,000		Monterey	$580,000	
Tehama	350,000		San Benito	125,000	
Trinity	15,000	$795,000	Santa Barbara	694,074	
Division III.			San L. Obispo	385,000	$1,784,074
Butte	$325,000		**Division VI.**		
Colusa	486,000		Fresno	$150,000	
El Dorado	150,000		Inyo	100,000	
Glenn	268,000		Kern	640,000	
Placer	250,000		Kings	105,000	
Sacramento	----		Mariposa	----	
Solano	350,000		Merced	220,000	
Stanislaus	210,000		Mono	50,000	
Sutter	105,000		Tulare	265,000	$1,530,000
Tuolumne	100,000		**Division VII.**		
Yolo	50,000		Imperial	$380,000	
Yolo-Sac'to	627,000		Orange	400,000	
Yuba	40,000	$2,961,000	Los Angeles	1,195,000	
Division IV.			Riverside	100,000	
Alameda	$400,000		San Bernardino	193,000	
Contra Costa	300,000		San Diego	522,000	
Marin	150,000		Ventura	521,926	$3,311,926
Napa	125,000		Total	$13,720,000	
Santa Clara	638,000		General	4,280,000	$18,000,000

Some of the above bond sales to counties were negotiated by local banks and private persons and a considerable portion of bonds credited to Los Angeles County were allotted to that county with the understanding that the proceeds might be expended in the discretion of the Commission on road work in other southern counties.

In passing it is significant and pertinent to remark that the purchase of these depreciated highway bonds by the various counties to the amount of $13,720,000 is a fairly good expression of public approval of the kind of roads the Commission has adopted as its standard types, and a fairly good endorsement of the Commission's policy to consider efficiency as well as first cost, as the test of economy in road construction.

The above companion pictures, taken at practically the same location, show conditions in Ventura County along the state highway before and after Highway Commission constructed this section of the road. They graphically tell the story of the change in road conditions generally wrought by the state highway in the various counties.